OFFICIAL PUBLICATION

JOURNAL

Heating • Refrigerating • Air Conditioning • Ventilating

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS

There is 30% lower pressure drop with smooth-flow air ducts *(p. 66)*

It takes time to remove system moisture with desiccant driers *(p. 59)*

Calculations of residential cooling loads *(p. 43)*

Problems of space cabin refrigeration and artificial gravity *(p. 50)*

To inhibit corrosion on steel tubes in low pressure boilers *(p. 72)*

Where oil burner noise originates *(p. 53)*

OCTOBER 1960

Electrowheel®*

another LAU "first in the industry"

Here's another Lau first, designed to help solve those cramped space blower installation problems. The versatile Lau "Electrowheel" is recommended for use whenever air moving efficiency is a requirement but space limitations present a problem. The "Electrowheel" is extremely efficient when operating where the utmost in compactness and smooth, quiet operation is required.

Lau "Electrowheel" features include stationary rubber mounted shaft, sealed ball bearings, rigid one piece motor mounts, 30" motor leads with BX connector and the same high standard of quality found in every Lau engineered product. One moving part assures years of trouble-free service.

When an installation requires a high performance blower the Lau "Electrowheel" is the logical answer. Write for Lau Catalog LSO-463 for complete information.

So named because a high quality external-rotor motor forms the wheel hub . . gives you more air delivery in a small package than ever before possible!

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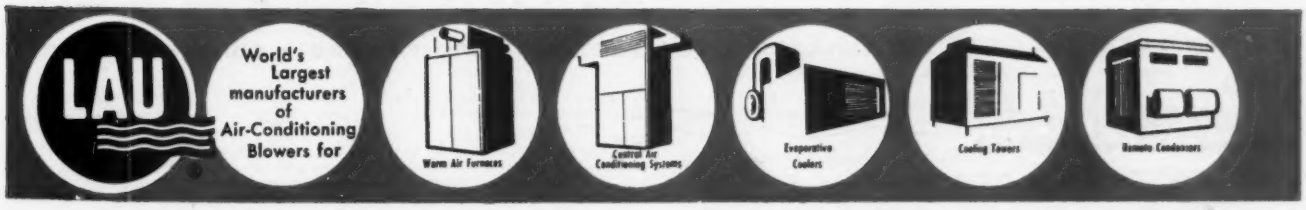

OCTOBER
1960

VOL. 2 NO. 10

OFFICIAL PUBLICATION

JOURNAL

Formerly Refrigerating Engineering including Air Conditioning, and incorporating the ASHAE Journal.

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Comment

WHEN THE MAN BITES THE DOG

News, like humor, links almost inescapably with the unexpected.

When a reader, or viewer, has had the opportunity to anticipate thoroughly that which is to be reported, there remain truly minimum news values.

We would not emphasize such trivia of the editorial office were it not that recent events reveal a certain lack of appreciation of such matters among some of those who may cooperate with us.

Specifically, our 88 Chapters will hold a presumable 800-900 local meetings during the coming 1960-1961 season. Discounting the purely social, each monthly meeting will have had some purpose and so such news as may ally with it may become matters of timeliness and significance.

What the member-readers of the ASHRAE JOURNAL may find to be of interest in regard to happenings at the meeting of any one Chapter has little to do with such applied words as interesting, well-attended, happy occasion, well-received, etc.

What is far more likely to be of value is the reporting, tangibly and specifically, of what was discussed as related to more than local happenings and, importantly, what the speaker of the evening added to the knowledge or awareness of those in attendance; to timeliness and significance.

UNINITIATED VS. INITIATED NEWS

Any Editor is essentially on the receiving end. He takes that which is originated by the course of events, out of assignments to others, as the result of a desire for publicity on the part of organizations or individuals, or as the result of specific research, and presents the outcome in palatable form for a selective and selected audience.

On the giving end quite frequently is someone whose objectives are entirely different; someone who, either on his own behalf or that of others, wants to have a certain impression created within the medium for which the Editor is responsible.

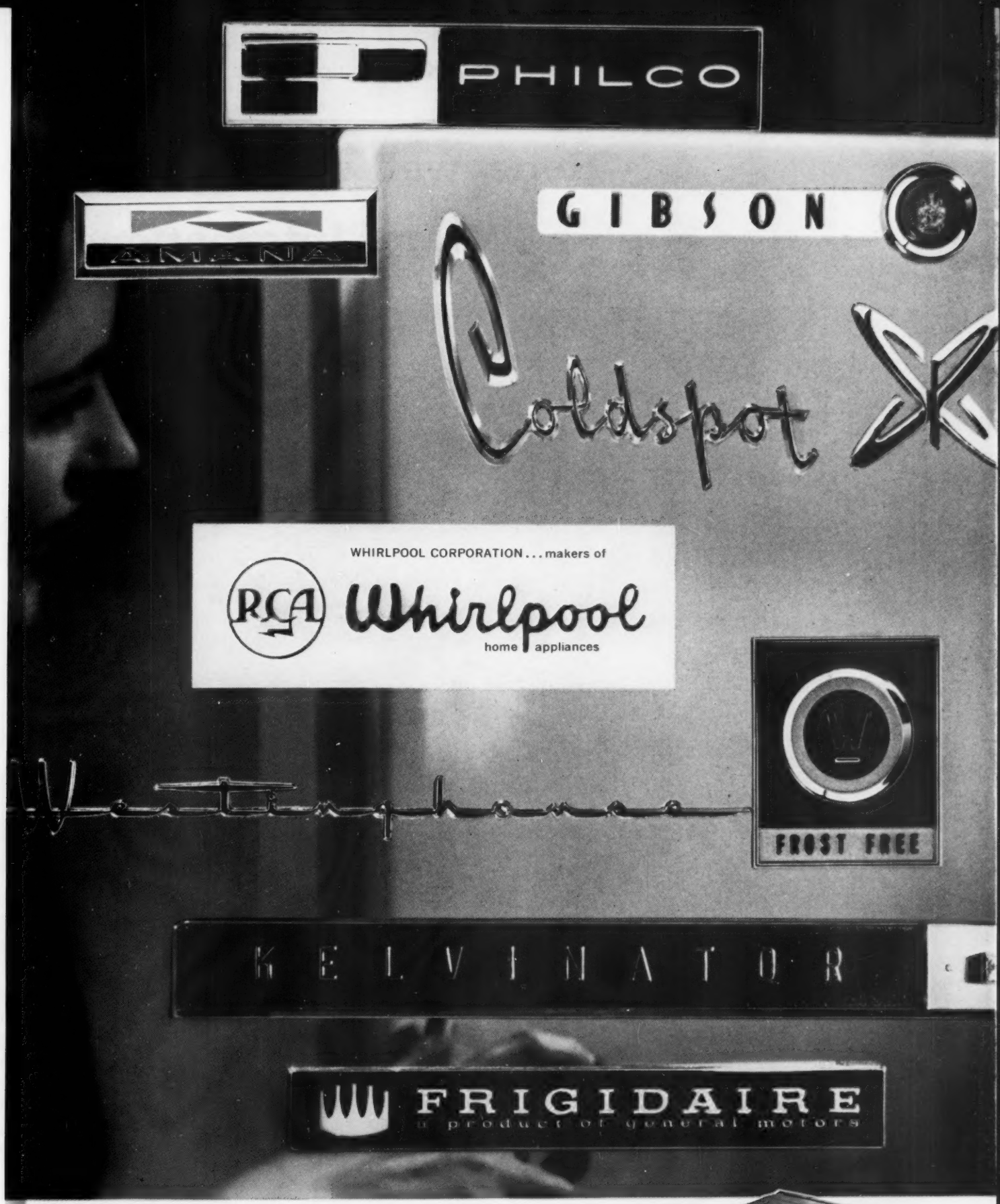
All of which becomes a matter of intelligent cooperation toward what should be a mutual goal.

AN INFORMED MEMBERSHIP

There is an ancient phrase that is almost the essence of any modern Public Relations program. The words are found in a generally revered volume where the failure of a once-popular administrator was traced to his becoming a legend rather than being a fact; to where tradition supplanted reality. The phrase is ". . . and there arose in Egypt, a new generation that knew not Joseph".

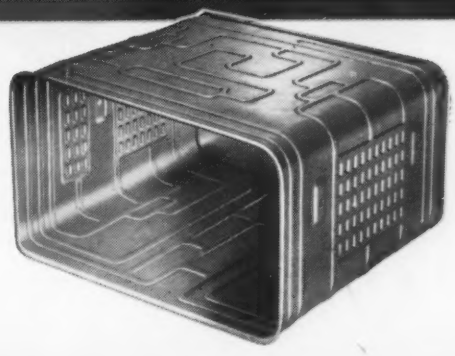
The Josephs, be they corporations, leaders or Societies, had better not have it come about that the newcomers do not know them and the pertinent facts.

Edward R Searles
Editor



Look who's cooling with ~~ROLL-BOND~~

evaporators by Olin



OLIN MATHIESON METALS DIVISION, East Alton, Illinois

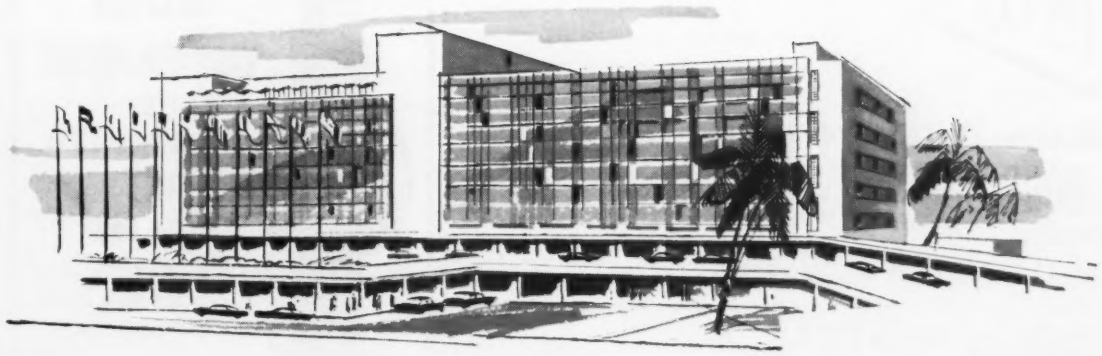
Producers of: Roll-Bond, Western Brass and Olin Aluminum

Mr. Ed Smith, Miami Manager, The Poole & Kent Company, Mechanical Contractors, says:

"Honeywell service really Miami International

Mr. Smith on the airport observation deck overlooking the Miami International Airport Hotel. Honeywell temperature control in the hotel keeps travelers as comfortable as possible.

paid off for us on the Airport Hotel job"



Architect: Steward-Skinner Associates
Consulting Engineer: Mitchell-Gordon Associates
General Contractor: Fred Howland, Inc.
Mechanical Contractor: The Poole & Kent Company

Engineers from Honeywell's Miami office were always available and eager to help

"When we installed the Honeywell temperature control system at the Miami International Airport Hotel," says Smith, "Honeywell men were ready to handle any problem encountered. But Honeywell engineers had planned the system so well, we were easily able to maintain job progress."

According to Smith, "This is very important to our operation. Accurate shop drawings . . . the right equipment . . . there can't be a slip-up, or unprofitable delays will be encountered. This isn't likely to happen with Honeywell men on the job. Honeywell supervises a job from start to finish; and the equipment is the best available."

You get more to work with when you work with Honeywell. Easily installed controls, accurate specifications, prompt delivery and excellent supervision are the advantages enjoyed by every contractor with Honeywell on his team.

Call your local Honeywell office for details. There are 112 conveniently located across the nation. Or write Honeywell, Dept. AH-10-116, Minneapolis 8, Minnesota. In Canada, contact Honeywell Controls, Limited, Toronto 17, Ontario.

The Honeywell temperature control system installed in the hotel includes 270 individual room thermostats.

Honeywell

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Sales and service offices in all principal cities of the world. Manufacturing in the United States, United Kingdom, Canada, Netherlands, Germany, France and Japan.

CARRY IT FURTHER

To the Editor:

I was much interested in the article "How Higher Cooling Coil Differentials Effect System Economies" by B. P. Morabito, in the August 1960 JOURNAL. While Mr. Morabito's presentation is accurate comparing 14.6 F rise with a 10 F rise, I think he would find it interesting to carry this comparison on further to a 24 F rise. Where water temperatures leaving the water cooler in the magnitude of 42 F are used, ranges as high as 30 to 32 F frequently pay off in many ways.

Somewhat less than two years ago we worked with the Carrier Corporation selecting compressors for a department store installation in Rochester, which I believe has been visited by members of Mr. Morabito's department. There are presently installed two Carrier Model 19C Centrifugal Compressors having a kilowatt input of 251 kw each. This plant was laid out for the ultimate addition of a third stage, which would total 1325 ton when 1325 gpm were circulated. This is a 24 F rise, and the coils were selected on this basis.

If two Carrier standard units had been used for the first two stages circulating 668 gpm through the coils, we would have obtained approximately 600 ton of refrigeration, which would have reduced the kw input substantially below the normal rating. By working with Carrier engineers and increasing the surface equivalent to about two sizes larger on both the water cooler and condenser, the tonnage of the two compressors in series increased approximately 68 ton. The result was that the cost per ton with the increased surface was less than the cost per ton on the standard system.

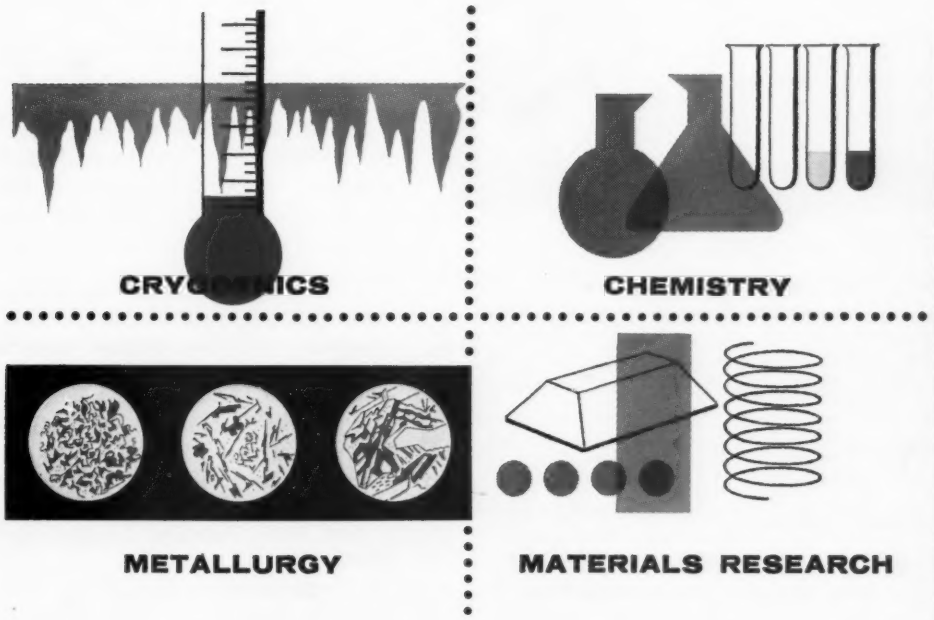
However, the third stage produces the most interesting results of all. Carrier quoted us on a compressor which will have 625 ton capacity when cooling 1325 gpm from 72 F to 60.65 F, and will have a compressor motor rated at 490 hp and 398 kw. This is 27.5% above the capacity rating of the compressor at 1 hp per ton, and a 22% reduction in horsepower, again on the basis of the usual 1 hp per ton.

If Mr. Morabito will carry his studies further to include three stages in place of two, and 20 to 30 F rise through the coils, the gains will be substantially greater than shown for the two stages and the 14.6 F rise. The savings in piping, pumps, insulation, etc., is quite a factor.

Mr. Morabito's article brings out the importance of rating water cooling systems above 50 F leaving water, which is now standard with all manufacturers. Supplements could well be issued tak-

UNION CARBIDE announces a new personalized assistance program for air conditioning and refrigeration equipment manufacturers. Through your UCON Brand Refrigerants representative, CARBIDE offers you the experience of hundreds of specialists in cryogenics, metallurgy, chemistry and materials research.

Can CARBIDE technology help you find better lubricants? Help you solve special corrosion problems? Assist you in developing plastics and elastomers? See your UCON Refrigerants representative ... and find out how this new personalized assistance program can work for YOU!



A new 96,000 square foot laboratory at Tarrytown, N. Y. will be an important part of CARBIDE's new assistance program. In this building, scientists and technicians from all areas of Union Carbide Chemicals Company's wide-ranging activities will pool their research experience to help you find practical answers to your problems. Your UCON Refrigerants representative makes this concentrated experience available to you, through CARBIDE's personalized assistance service. See him, soon! Call, write or wire UCON Refrigerants, Union Carbide Chemicals Company, 270 Park Avenue, New York 17, N. Y.

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BRAND refrigerants

These 5 UCON Brand Refrigerants will meet your refrigeration and air conditioning needs

UCON Refrigerant 11 Trichloromonofluoromethane
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UCON Refrigerant 22 Monochlorodifluoromethane
UCON Refrigerant 113 Trichlorotrifluoroethane
UCON Refrigerant 114 Dichlorotetrafluoroethane

UNION CARBIDE CHEMICALS COMPANY *Division of Union Carbide Corporation*
270 Park Avenue • New York 17, New York

ing water temperatures up to at least 65 F. For low compression ratios, especially with 85 to 90 F leaving condensing water, increased surface in the water cooler and condenser will then result in a lower cost per ton and lower operating power per ton.

Staging of condensers, or combination of series and parallel flow permits lower condensing pressures on some stages, which also can frequently result in benefits and economies. We have many installations, some operating as long as five and six years to prove these benefits.

A. I. McFARLAN,
President

A. I. McFarlan Co., Inc.
New York, N. Y.

ASHRAE will hold 4-day Semiannual Meeting

Preliminary planning, for the ASHRAE Semiannual Meeting to be held in Chicago, February 13-16, 1961, has resulted in a particularly well-balanced technical program, a diversity of Symposiums and a somewhat different plan for Forums. Individual papers have not been scheduled definitely, but on Monday, February 13, there will be a Technical Session on Combustion and another upon Insulation. On the same day there will be a Symposium in regard to Frozen Foods.

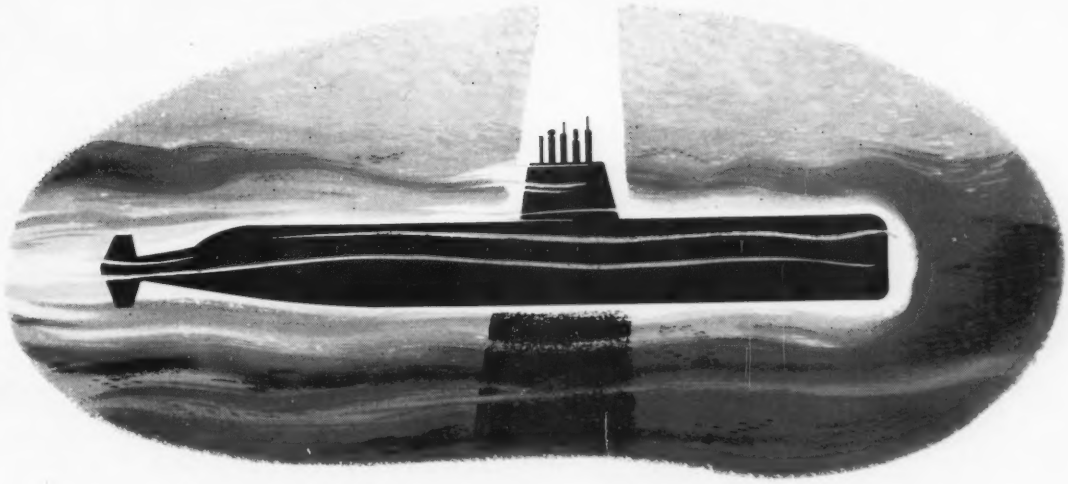
Refrigeration will be the subject of the Technical Session on Tuesday accompanied by two Symposiums, one on Heating and the other on Air Conditioning. Wednesday will bring a special session for the delineation and discussion of the Research and Technical Program and plans of the Society. On this day, there will also be a Symposium on Domestic Refrigerator Engineering.

The last day of the Semiannual Meeting will have a session rounding up several significant general subjects as well as a Symposium on Ventilation.

Heretofore, Forums have been held concurrently, or at least in the same afternoon; this time there are planned a possible total of six to be divided over Monday, Tuesday and Wednesday.

Reported elsewhere in this issue, plans for the 15th International Heating and Air-Conditioning Exposition to be held concurrently with the ASHRAE Semiannual Meeting already indicate a large, if not record-breaking number of exhibitors.

Preliminary correspondence foretells that when room reservations at the Conrad Hilton Hotel are assigned there may be a new high in attendance involved. It is currently estimated that more than 3000 members and guests will have registered for this notable ASHRAE Meeting.



how activated charcoal solved a no. 1 problem of our atomic subs ...fresh air

The scarcest commodity aboard our atomic subs is not fisionable material—it's plain old fresh air.

Take a hundred men, hermetically seal them in a huge steel tube, then submerge the tube for days at a time.

Call the result the "Nautilus" or the "Triton" and you have an idea of the problem of building submarines to utilize the power potential of nuclear energy. They can literally stay submerged as long as the crews can stand the confinement.

Even without other contamination, just breathing would soon make the air within the tube unbearable. Then add body odors, a kitchen, a lot of complex machinery, areas where smoking is permitted, lavatories and waste tanks and you have a real problem.

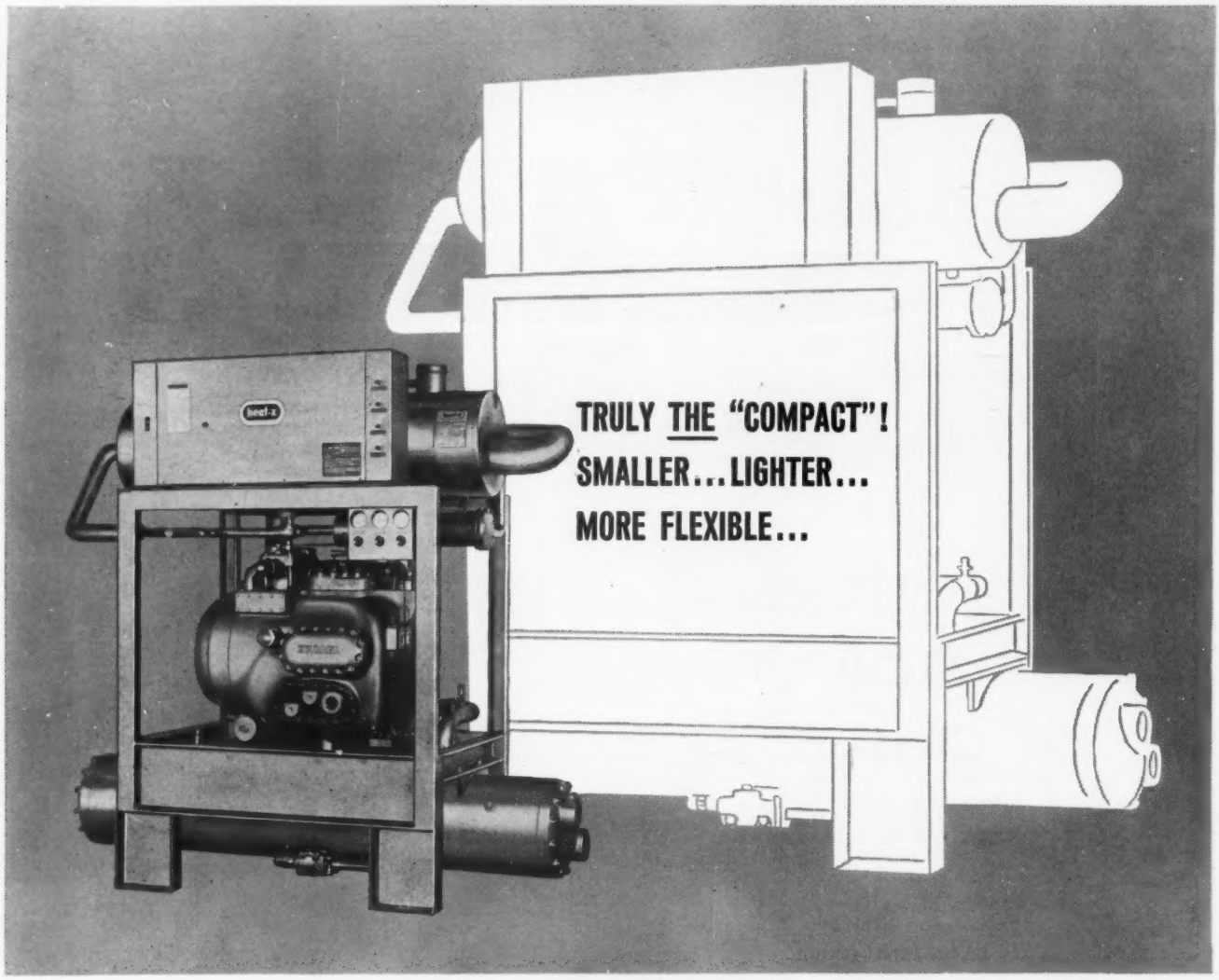
To solve the problem, the Navy turned to one of the oldest and most effective methods of air purification—adsorption by Activated Charcoal.

Barnebey-Cheney Activated Charcoal filters are a standard part of the subs' air conditioning systems. Others are installed on the waste tank vents, still others in the lavatories. Odors and contaminants are trapped and held in the Barnebey-Cheney Activated Charcoal.

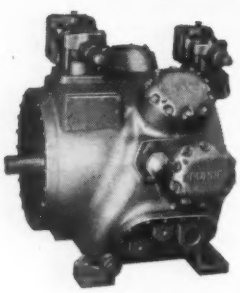
The same principle can be applied to heating, ventilating and cooling of homes, offices, schools, hospitals or public buildings where fresh, healthful, odor-free air is essential. Barnebey-Cheney builds a complete line of air purifiers for applications of any size, from disposable filters for window coolers to central system purifiers for the huge new Dallas Auditorium.

As in the atomic submarines, *true* air conditioning *must* include *air purification*. Activated Charcoal is the proven, practical means of accomplishing it. To learn more, write for Bulletin T352, Barnebey-Cheney, Columbus 19, Ohio.

Barnebey Cheney



NEW SPACE SAVING heat-x PACKAGE CHILLERS PACK MIGHTY COOLING CAPACITIES



POWERED BY THE FAMOUS BRUNNER MULTI-DRIVE COMPRESSORS, (HERMETIC OR DIRECT-DRIVE TYPE) RENOWNED FOR FIELD-PROVEN DEPENDABILITY

Greater cooling capacity with much less bulk—that's the story on this new line of Heat-X units for chilled water air conditioning and industrial water cooling applications.

Note the superior features of these ruggedly reliable, top performing chillers, available in capacities from 20 through 100 tons, completely self-contained, ready to install: Exclusive, space-saving Inner-Fin® chillers and heat interchangers • Chilled water passages of non-ferrous construction • Cleanable condenser-receivers • Capacity modulation and unloaded start • Indicator lights.

All necessary components . . . *often "extras" with others but always "standard" with Dunham-Bush* . . . include: gauges, thermostats, reversible oil pump, oil failure control, high-low pressure control, relief and purging valves, solenoids, expansion valves, filter-drier, liquid sight glass, control panel.

Though it's infrequently needed, when service is necessary it's simple. Just a glance at Heat-X Package Chillers shows the reach-in easiness for quick and economical servicing.

And don't forget, every part of every Heat-X Chiller is backed by a single source manufacturer's responsibility.

Get the facts. Request Heat-X Form No. 8023A.

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AIR CONDITIONING • REFRIGERATION • HEATING • HEAT TRANSFER

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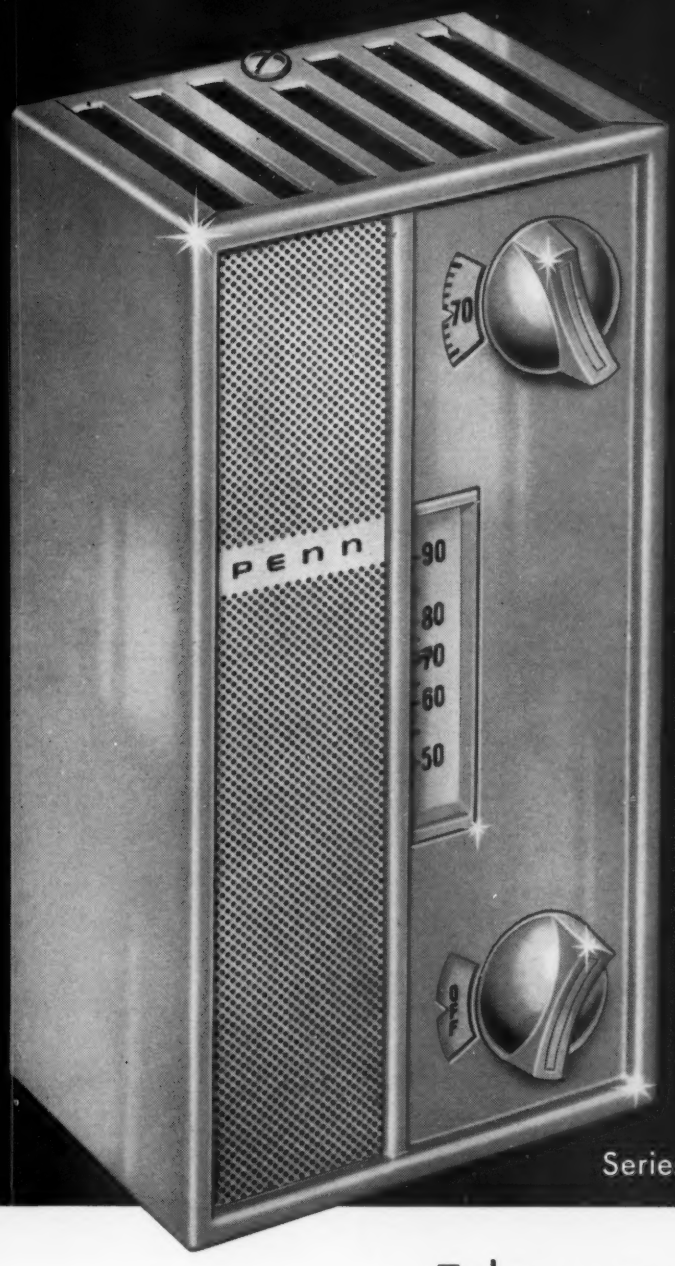
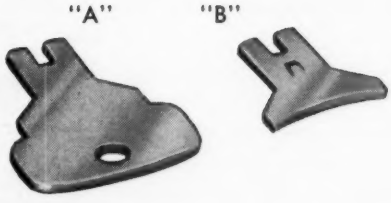


NEW

line voltage THERMOSTAT with front panel control of all heating-cooling functions!

Series 822



How settings are locked

Where it is desirable to lock settings, installer removes cover and pushes out factory-installed key "B" from each adjusting knob. This disconnects knob from adjusting shaft. Then, user may insert special key "A" (supplied for key chain use) through knob slot and turn to make desired settings . . . remove key and thermostat is locked as adjusted.

Take your choice...heating, cooling or heating-cooling...each features unique, easy-to-use, locking-type knobs

Here's the line voltage thermostat that has "everything" desired for accurately controlling temperature in motels, schools, offices and similar installations.

It has easy-to-read temperature and function selector dials. It has an accurate bimetallic thermometer with vertical dial. It has exclusive, locking type adjusting knobs, attached to cover but connected to adjusting shafts by factory-installed "keys" within the knobs. It has a unique, built-in but concealed adjustable high limit stop for temperature dial. It has an unusually sensitive element and mechanism which provide low operating differential at all voltages and all amperages within its rating. It has easiest "field wiring" ever...simply connect to large terminals *on back of thermostat.* And, it has modern "thin-line", compact styling. Learn more about this new thermostat...write to the Penn factory for Bulletin 3233.

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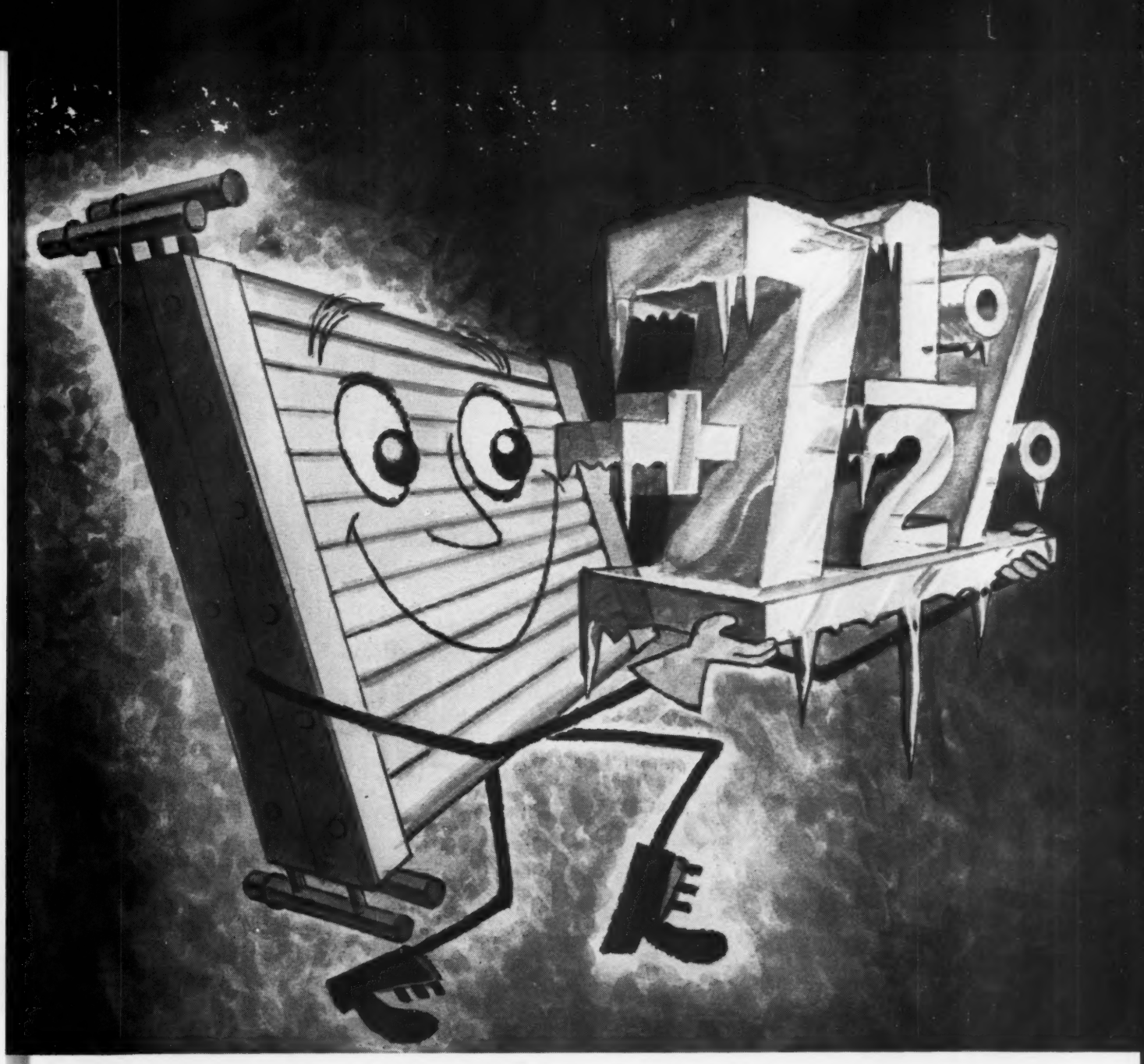
EXPORT DIVISION: 27 E. 38th ST., NEW YORK, N.Y.

AUTOMATIC CONTROLS FOR HEATING, REFRIGERATION, AIR CONDITIONING, APPLIANCES, PUMPS, AIR COMPRESSORS, ENGINES



Want a 7½% increase in refrigeration capacity for the same horsepower?

Use Halstead & Mitchell cleanable water-cooled condensers

Test results indicate an average of 15 degrees of subcooling in H&M condensers because of true counterflow of refrigerant and water. Since liquid refrigerant leaves the condenser at a lower temperature, system capacity is increased about ½% for each degree of subcooling—without additional power input.

But that's not all: Halstead & Mitchell Water-Cooled Condensers have easily removable end plates for quick, safe, *mechanical* cleaning of the water passages. Scale and sludge are quickly removed so that condenser efficiency stays high; operating costs, low.

Featuring double-tube design, seamless copper tubing and brass headers, H&M condensers are available in ⅓ to 25-ton capacities. All are U/L approved, and can be used singly or in multiples on racks. Ask your H&M refrigeration wholesaler for complete information, or write Halstead & Mitchell Co., Bessemer Building, Pittsburgh 22, Pa.

H&M WATER-COOLED CONDENSER WITH TRUE COUNTERFLOW

HM

Halstead & Mitchell

Air Handlers • Finned Coils • Air-Cooled Condensers • Cooling Towers • Water-Cooled Condensers

Late news highlights

Food research Appropriating $2000 for the initiation of cryogenic research on foods at Colorado College, the Refrigeration Research Foundation seeks to put new knowledge to work. The range of exploration is −300 to −400 F and the study will link primarily with liquid nitrogen and such other liquid gases as have been used as refrigerants in space vehicle development.

Thermal engineering As a projection of "Elementary Heat Power" by the same authors, "Thermal Engineering" adheres to the first law of thermodynamics and its applications for its basic theme. Discussed by authors Harry L. Solberg, Orville C. Cromer and Albert R. Spalding are: Major types of prime movers, heat exchangers and compressors with emphasis upon construction, operation, performance and specific limitations. The 650-page text is liberally accompanied by illustrative material, computational examples and numerous problems for solution. John Wiley & Sons, Inc., 440 Park Avenue South, New York 16, N. Y.

RSES to meet Scheduled for October 20-23, the Refrigeration Service Engineers Society will hold its 23rd Annual Convention in Portland, Oregon. Speakers will include ASHRAE members: Rudy Berg (President of ARI), W. H. Larson of Tacoma, Wash., A. E. Manning (Past President of RSES) and Dr. W. O. Walker of the University of Miami.

Standardization in the U.S. Descriptive of the work and objective of various organizations, public and private, active in standardization projects, "Standardization Activities in the United States" is a 210-page guide with alphabetical listings. Available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for $1.75.

Engineering-management For ten days, beginning January 23, 1961, the University of California will conduct its 7th Engineering and Management Course at the UCLA campus. Reviewed will be various broadly applicable problems. There are 23 subjects available to attendants. No formal educational requirements are demanded but enrollment is limited to assure a maximum opportunity for full participation.

Freeze-drying Held in Lyon, France, August 29 to September 9, the Second International Conference on Lyophilization drew representatives from nearly 30 countries who sought to explore the vacuum freeze-drying principle and its applications to the preservation of such foods as meats, fruits, vegetables and seafoods. The Conference was sponsored jointly by the International Institute of Refrigeration and the International Association of Microbiological Societies.

Apprentices graduate Marking the fulfillment of a joint industry and labor effort to increase the number of trained qualified journeymen for service and installation work in air conditioning and refrigeration, 30 apprentices were graduated last month from a five-year training course sponsored by the Certified Refrigeration and Air Conditioning Foundation. This training program was started in 1941 by a joint labor and management committee of the Southern California refrigeration and air conditioning industry.

SPE Transactions As of January 1961 the Society of Plastics Engineers will sponsor SPE Transactions, a quarterly scientific journal containing both original and review material in complete and abridged forms. Transactions, supplementing the SPE Journal, will emphasize basic science and engineering, as allied with high polymers, while the monthly journal will publish technical articles of broad general interest and news of technical significance.

Research training

As announced by the National Science Foundation, that organization has granted $15,125 to the Scandinavian Council for Applied Research. Opened are opportunities for scientific research and training for a one-year period in Norway, Sweden and Denmark for five United States scientists. Fields of applicability are acoustics, corrosion, chemical engineering, automation, microbiology, biotechnology, mass spectrometry, speech transmission and calorimetry. The grant provides on the average $875 for institutional costs, $1500 for stipends and $700 for travel for each United States participant. Application may be made to the Scandinavian Council for Applied Research, Gaustadallen 30, Blindern, Norway.

Air pollution

Creation of a new Division of Air Pollution within the Public Health Service has been announced to consolidate those research, technical assistance and training activities conducted since 1955 under various air pollution engineering and medical programs. Chief of the new division will be Vernon G. MacKenzie, presently Assistant Chief, Research and Development, Division of Engineering Services. Objective is to facilitate research and technical assistance techniques and knowledge as well as to coordinate more efficiently medical and engineering liaison with state health departments, industry, university and all other private and government groups. Two laboratory research branches will be established, Laboratory of Medical and Biological Sciences and Laboratory of Engineering and Physical Sciences.

WAHACA in November

Calling for " . . . the industry to take off the gloves and become a little angry about its needs," Pres. Harry C. Gurney of the NWAHACA has announced that the 47th Annual Convention starting November 14th will be an intensive 3-day discussion of problems and the best way to get action. The meeting is being held in Cleveland, and while the main Convention session will deal with application engineering, others will cover dealer-contractor sales and business management.

Ottesen medal

Awarded to Dr. J. C. Fidler of the United Kingdom, Department of Scientific and Industrial Research, at the 10th International Congress of Refrigeration in Copenhagen, the A. J. A. Ottesen medal then awarded was the first to have been made. The Award is to one actively engaged in and having done outstanding work in the field of refrigeration science or technology. It is named for A. J. A. Ottesen, who is credited with having put into use the first generally adopted method for quick-freezing of food.

The human equation

As a sort of job slide-rule to measure the Human Equation, the Career Finder is an unusual vocational guidance aid. Requires about an hour to complete a record without supervision, and perhaps, 6 minutes to score any member of the personnel staff. Developed by Dr. Keith Van Allyn, Director, Personnel Research, Inc., 627 Windsor Boulevard, Los Angeles 4, Calif. The device is cited as suitable for all types of jobs for a single test in measurement of aptitudes, capabilities, limitations and potentialities. $2.00.

Battelle defines

Describing in a step-by-step manner, the relationship between a client and a research institute, "Procedures of Contract Research for Industry" is a comprehensive folder and of more than limited interest to a single project as published by the Battelle Memorial Institute, Columbus 1, Ohio. This double-folder covers the bases for much of the research reported from time to time by ASHRAE.

ICR Proceedings

Proceedings of the 10th International Congress of Refrigeration as held in Copenhagen, August 1959, have been completed and are being published as "Progress in Refrigeration Science and Technology." The report consists of three volumes and is cited as including probably the most comprehensive collection of up-to-date material in the field of low temperatures and the application of refrigeration. Covered are many aspects of low temperature physics, subjects regarding heat transfer calculations, considerations regarding insulating material, refrigeration machinery and air conditioning. A large section is devoted to the use of refrigeration in the food industry. A complete subject index is included. Pergamon Press, 122 East 55th Street, New York 22, N. Y. Prepublication price $38 (after November 1, $60).

Imperialine

EXTRUDED ALUMINUM GRILLES

TUTTLE & BAILEY

Imperialine

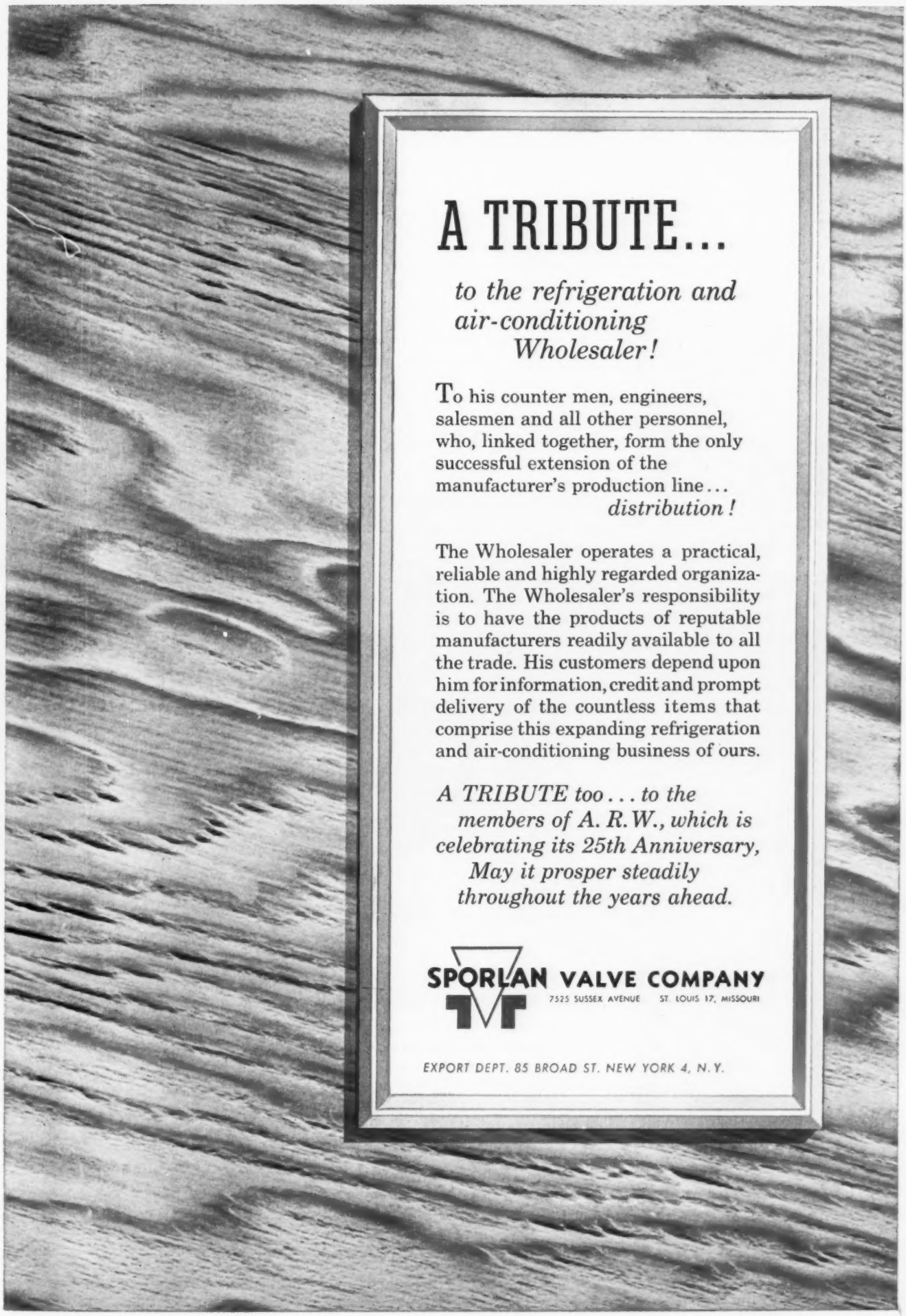
EXTRUDED ALUMINUM GRILLES

Featuring trim, attractive, straight-line styling, Tuttle & Bailey Imperialine EXTRUDED ALUMINUM GRILLES are the answer to architectural demands for air distribution equipment that will harmonize with, or accent, linear design concepts. Universal in application, Imperialine Grilles may be used on the supply or return portions of heating, cooling, or ventilating systems and are ideal for ceiling, sidewall, floor, or sill installation. A Tuttle & Bailey exclusive, the grilles are standard with satin anodized finish. Special finishes and colors are also available.

For complete catalog data on Imperialine Extruded Aluminum Grilles, ask your nearest T&B Representative or write direct.

TUTTLE & BAILEY
division of Allied Thermal Corp.
New Britain, Connecticut

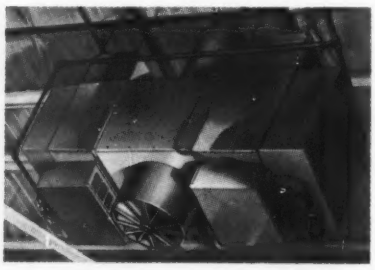
TUTTLE & BAILEY PACIFIC, INC. City of Industry, California


A TRIBUTE...
to the refrigeration and air-conditioning Wholesaler!
To his counter men, engineers, salesmen and all other personnel, who, linked together, form the only successful extension of the manufacturer's production line... distribution!
The Wholesaler operates a practical, reliable and highly regarded organization. The Wholesaler's responsibility is to have the products of reputable manufacturers readily available to all the trade. His customers depend upon him for information, credit and prompt delivery of the countless items that comprise this expanding refrigeration and air-conditioning business of ours.
A TRIBUTE too... to the members of A. R. W., which is celebrating its 25th Anniversary, May it prosper steadily throughout the years ahead.
SPORLAN VALVE COMPANY
7525 SUSSEX AVENUE ST. LOUIS 17, MISSOURI
EXPORT DEPT. 85 BROAD ST. NEW YORK 4, N.Y.

PARTS and PRODUCTS

GAS-FIRED HEATERS

Designed for installation at heights up to 36 ft, IGV vertical discharge units for industrial applications deliver large volumes of air at high velocities and comfortable final air temperatures to heat working areas, even when installed above craneways and other plant equipment. Units are



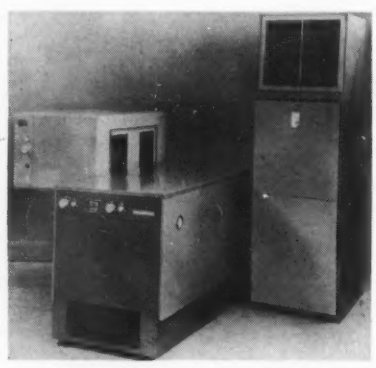
suited to introduction and circulation of fresh air for ventilating purposes.

In spite of their relatively high heating capacities—300,000, 450,000 and 600,000 Btu hr input—units weigh only from 383 to 680 lb, permitting them to be suspended directly from existing structural members of a building. Motors range in size from ½ to one hp. Burners are stainless steel and heat exchangers are either stainless or aluminized steel.

Modine Manufacturing Company, 1500 DeKoven Ave., Racine, Wisc.

NINE-TON UNIT

Featured on the new RA-110 unit is a single dual-circuited "air-film" condenser and condenser blower, with twin hermetic compressors. Applica-



tion is for air conditioning of two areas, such as two adjacent stores or two floors of a store, or for installations subject to wide variation of heat gain. Separate controls provided for each compressor include a time-delay relay to prevent both compressor motors from starting at the same instant.

For operation in low ambient temperatures and for year-round commercial use, a low ambient temperature head pressure control system and a water dump-and-fill system are optional accessories. Capacity of the nine-ton unit is 110,000 Btu/hr.

Condensing unit (center of cut) is shown with horizontal and vertical air handlers to illustrate application in cooling two separate areas from the single unit or operating the air conditioning system for two different stages of cooling.

Rheem Manufacturing Company, 7600 S. Kedzie Ave., Chicago 52, Ill.

PORTABLE INDICATOR

Suitable for many applications in steam-generating plants and general industry, a two-lb, battery-powered portable temperature indicator, Model 583, is equipped with thermistor sensing probes and batteries having an estimated life of several thousand hr. It is available in ten ranges, span-

ning –30 to 350 F, and uses interchangeable probes for air, liquid and surface temperature sensing.

Fenwal, Inc., Pleasant St., Ashland, Mass.

FIVE-TON UNIT

Self-contained, this five-ton water-cooled summer air conditioner can be used either as an add-on unit with a forced air furnace or for summer air conditioning only. Unit No. H-512-W is shipped completely assembled, equipped with a top outlet and slide-out filter frame for connection to ducts. For installations where air is to be taken directly from and discharged directly into the conditioned room or space, an accessory discharge plenum with grille and a louvered intake grille can be added readily.

Cooling circuit of the unit is comprised of an hermetically sealed, heavy-duty compressor, large-area cooling coil and tube-in-tube condenser coil. Service valves, refrigerant drier and fusible pressure-relief valve are standard equipment. Net cooling capacity is rated at 64,000 Btu/hr under standard conditions.

Henry Furnace Company, Medina, Ohio.

LOW VOLTAGE THERMOSTAT

For controlling both oil and gas heater temperatures between 55 and 85 F, Model 188 is a two-wire, low voltage, horizontal thermostat of the heat anticipating type. Contact used is a single-pole, single-throw, bimetal actuated snap type.

Three basic parts comprise the unit: mounting bracket, base and cover. Cover is secured to the base by means of a friction snap. Two screws are provided to secure the mounting bracket to a wall and no leveling of the device is necessary.

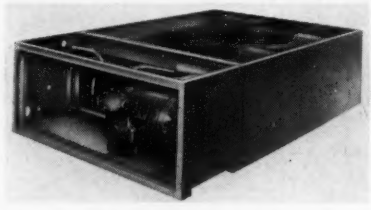
Controls Company of America, Heating & Air Conditioning Div, 2450 N. 32nd St., Milwaukee, Wisc.

NINE AIR CONDITIONERS

Ranging from 10 to 50 ton in capacity, nine large packaged air conditioning units comprise this new line. Indoor and outdoor heat pump sections are being offered for the first time by this manufacturer in a ten-ton size. Model 38AC012, the outdoor section (shown), utilizes two large, quiet propeller fans direct-driven in an upflow direction. Compressor, controls and most piping are arranged in one end of the unit. Heat and sound are both directed upward; no wind deflectors are necessary.

An adaptation of the existing ten-ton, cooling-only, fan-coil unit, the indoor section (Model 40RT012) can be used horizontally or vertically with ductwork or as a free-standing unit with discharge plenum. Up to three strip heaters, 15.2 kw each, may be installed within the casing of the unit. A fourth row on the coil acts as a subcooler on heating cycle.

Two new 15-ton air-cooled condensing units, one with capacity con-



trol (Model 38AB016) and one without (Model 38AA016) have the same low silhouette as the ten-ton heat

WHY YOU SHOULD SPECIFY

Phelps Dodge Copper Refrigeration Tube

The Famous Mine-to-Market Quality Line!

1 HIGHEST GRADE COPPER. Phelps Dodge refrigeration tube is made of the finest copper from Phelps Dodge's own U.S. open-pit mines. Smelting and refining of the copper ore are also done by Phelps Dodge to assure lasting quality.

2 FINEST QUALITY CONTROL. Phelps Dodge refrigeration tube is carefully controlled for quality throughout fabrication, rigorously tested before being packaged to assure finest tube properties and lasting quality in service.

3 COLOR-CODED ACR TUBE. Phelps Dodge ACR tube is specially cleaned for refrigeration use. Extra-long coded end caps are your assurance of factory-clean tube at job site. Tube is color coded "ACR" for your protection.

Quality tube sold the quality way—through authorized wholesalers!

AIR-CONDITIONING AND REFRIGERATION WHOLESALERS A-R-W ASSOCIATE MEMBER

PHELPS DODGE COPPER PRODUCTS
CORPORATION
New York, N.Y. • Los Angeles, Calif.

PD

pump. Control box and compressor are located in a separate section which can be serviced without shutting down the condenser air flow. Capacity control unit has a one-third capacity reduction for partial load operation and comes equipped with a 24-volt, two-step cooling, one-step heating thermostat and a liquid line solenoid valve for deactivating part of the evaporator surface.

Designed for use with indoor self-contained units, a 15-ton air-cooled condenser (Model 09DC016) is virtually the same as Model 38AB016, but without compressor. Installed vertically or horizontally, it can be combined in multiples with five and ten-ton air-cooled condensers.

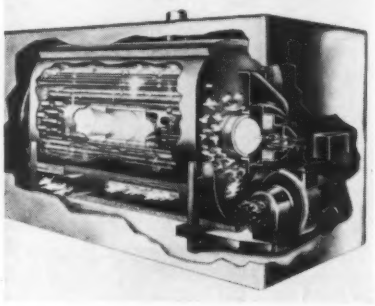
New 15 and 20-ton direct expansion fan coil units (Models 38RR016 and 38RR024) are compact and provide great flexibility of application. Fan motors and filters are mounted in the units so there is no overhang outside. Air handling capacity from 4500 to 10,000 cfm varies with fan motor selection of two, three or five hp. Units may be used for cooling only or as indoor heat pump sections. With various accessory panels, units can discharge air vertically or horizontally to the front or rear, can be suspended horizontally from the ceiling and used with a discharge plenum.

40 and 50-ton self-contained units (Models 41EE044 and 41EE054) are offered both with and without water-cooled condensers, giving the option of air-cooled or evaporative operation. Shell-and-tube condensers are connected to provide single inlet and outlet connections to a cooling tower, cutting field labor. Pre-wired electrical center prevents more than one compressor from starting at the same time.

Carrier Air Conditioning Company Div, Carrier Corporation, Syracuse 1, New York.

OIL-FIRED HEATER

Designated Model 24, this addition to the Dynatherm line of automatic



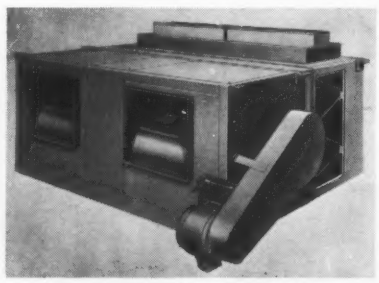
oil-fired heating package units is of the same design as larger capacity models, and will serve the needs of small residences. Gross output of the unit is 120,000 Btu/hr, forced hot water rating is 87,000 Btu/hr and firing rate one gph.

Optional is a tankless type domestic water heating coil which contains 40 lineal ft of straight-run copper tube cited as guaranteeing a hot water supply of three gpm. Independent of the need for chimney draft, unit is cited as operating under any draft conditions.

Dynatherm Div, Bethlehem Foundry and Machine Company, Bethlehem, Penna.

AIR HANDLERS

Available at ratings from 400 to 30,000 cfm for cooling, heating, ventilating, humidifying, dehumidifying, filtering and air conditioning, Centra-



laires match fan and coil face area to the system by offering two fan sizes and three coil sizes for each model. In addition, the units feature sectionalized design, channel frame construction for high strength and light weight and flush-mounted steel cabinets.

Among other features are: choice of internal or external face and bypass section, combination mixing box and filter section (or filter section only), drain pan under coil and blower section in all air conditioning units, extensive selection of filter types, vari-pitch V-belt drive and internal bearing arrangement for flush-against-the-wall installation.

Airtherm Manufacturing Company, Heating & Air Conditioning Div, P. O. Box 7039, St. Louis 77, Mo.

INSTALLATION PACKAGE

Reduction in time and expense involved in installing hydronic accessories used with a boiler is cited as having been achieved by a new all-in-one installation package. Designated Hydro-Flo Pak, it contains all the hydronic components normally used around a boiler, in addition to pre-engineered and pre-cut pipe fittings for fast, simple installation.

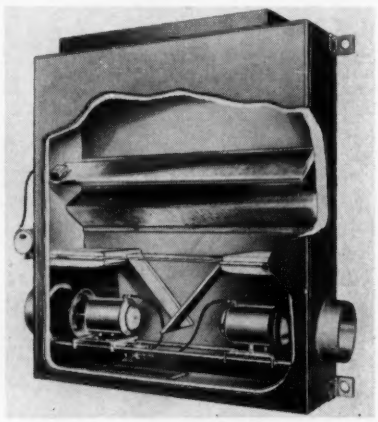
Included are a booster pump, Airtrol system and a choice of the proper relief or Flo Control valve or both. A compression tank is also included but is furnished separately. Parts in the package are engineered to fit most types of boilers: side or top outlet (upfeed or downfeed), right or left-hand installations.

Bell & Gossett Company, Morton Grove, Ill.

TERMINAL CONTROLS

Functions these acoustic terminal control high-velocity systems are cited as performing include: reduction of high velocities and pressures for discharge of air at low velocity values; proportioning of hot and cold flows in response to room thermostats; mixing of hot and cold flows to provide uniform temperature at discharge; attenuation of self-generated noise and duct air-borne noise; and automatic control of air discharge volume despite static pressure unbalance (or provision of manual volume control).

Three ceiling and two window/perimeter models are available, the former coming in six sizes and the latter in three. Ceiling units can be had in end, bottom and multi-discharge types, window/perimeter in a choice of front or top discharge. All models offer the option of single or dual duct, with full control selection, and window/perimeter models are



provided with either Curtainaire, Linear or Modular Diffusers.

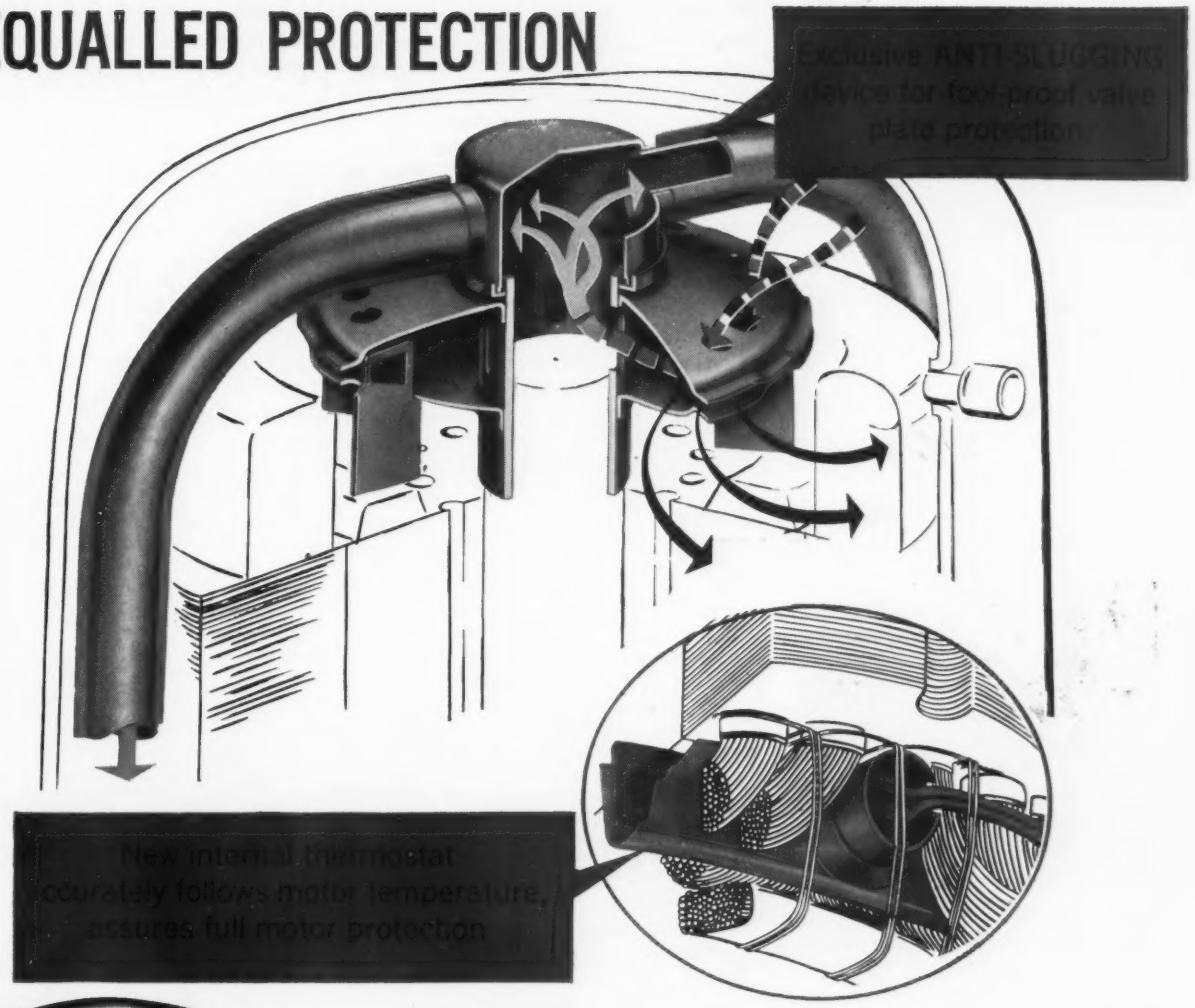
Construction features include: full acoustic baffling, one in.-thick acoustic lining, metal-protected lining edges, unobstructed flow path, positive mixing with integral blender, stable pressure-drop sensing tips, non-stick resilient valve seats and leak-proof casings.

Carnes Corporation, Verona, Wisc.

TRANSISTORIZED PANELS

Transistors have replaced vacuum tubes in this manufacturer's entire

UNEQUALLED PROTECTION



CL SERIES COMPRESSORS
CL25—rated at 30,500 BTU
CL30—rated at 38,500 BTU
CL35—rated at 43,500 BTU
CL40—rated at 50,500 BTU

WIDER SELECTION . . .

WITH TECUMSEH'S NEW CL SERIES COMPRESSOR

This 2-pole, R-22 line of CL compressors provides Tecumseh's air conditioning and heat pump customers with unmatched advantages. Dual internal protection is furnished on the 3, 3½ and 4 H.P. models (the 2½ H.P. model includes the centrifuge only) as standard equipment. With normal charge and runs, the fool-proof Anti-Slug Device prevents oil or liquid refrigerant from reaching the valve plates. The internal thermostat is built *into the motor winding* to give instantaneous and accurate sensing of motor temperature at the most critical point and therefore removes compressor from the line at a safe temperature level. Both devices are *always* operative when the compressor is running and are unaffected by outside variables. In combination, they offer compressor protection unequalled in the field. This broad line, offered to Tecumseh customers for the first time, provides a closer match to your requirements. A full year of successful field tests have proven the new CL Series your best compressor buy. Investigate it today.

forty million compressors in the field

TECUMSEH

TECUMSEH

MARION, OHIO
TECUMSEH, MICHIGAN

PRODUCTS COMPANY

FOREIGN OPERATING DIVISION: Tecumseh, Michigan

CANADA: Tecumseh Products of Canada, Limited, Ashland and Wilton Avenues, London, Ontario

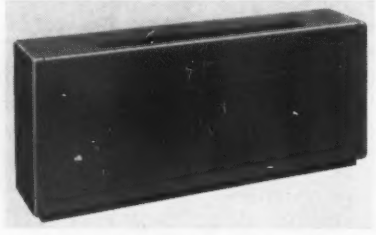
line of electronic temperature-control panels. Transistorized amplifiers are electrically and physically matched—in size, shape and connection—to the old vacuum tube amplifier, making possible plug-in replacement on older panels without rewiring.

In addition to longer life expectancy than vacuum tubes, new amplifiers will consume less power and radiate less heat.

Minneapolis-Honeywell Regulator Company, 2747 Fourth Ave. S., Minneapolis 8, Minn.

UNIT VENTILATORS

Designed especially for school installation, this line of equipment is offered in a range of five sizes from 500 to 1600 cfm. Units are designed



to be used with the company's Walvector, and are integrated into a companion line of storage cabinents.

Warren Webster & Company, Inc., 17th & Federal Sts., Camden 5, N. J.

PACKAGED BOILERS

Completely assembled, wired, tested, wrapped and crated at the factory, this new line of four, six and eight section gas-fired, cast iron packaged boilers for hot water heating systems have input ratings of 78,000, 115,000 and 150,000 Btu/hr. Boiler sections have wet base design and are approved for installation on combustible floors. They are designed for use with natural, manufactured, mixed and LP gases.

Dunkirk Radiator Corporation, Dunkirk, N. Y.

HEAT PUMP, FAN COILS

Now in production are a three-ton heat pump outdoor section (Model 38EG004) with 20% more capacity than its predecessor and two versatile fan coil sections (Models 40AA004 and 40AA006).

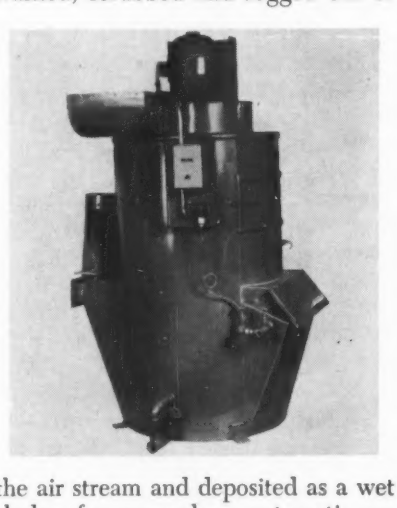
Heat pump section offers 36,000 Btu/hr cooling capacity and 38,500 Btu/hr heating capacity. It defrosts with hot gas only when outdoor conditions require it, and then auxiliary strip heaters are energized to prevent cool indoor drafts. Enabling the home owner to change from heating to cooling either manually or automatically is a low voltage control system. An indoor fan motor relay is an integral part of the unit control panel. Externally mounted crankcase heater prevents oil from absorbing refrigerant and a filter-drier is close-coupled to the capillary which controls refrigerant flow on heating cycle.

Use of optional coil sizes and any quantity of air movement from 900 to 2500 cfm is permitted by two new air handling units. They can be used in both heat pump and cooling-only applications and with ductwork or a discharge plenum. With accessories, they can be utilized in upflow, downflow and horizontal positions and with 230 or 115-volt power. The electric resistance heater package is removable for servicing, operates with 220 or 440 volt and single and three-phase current in 4.6 kw increments. If desired, the coils can be omitted to convert to an electric furnace. Fan motors are of 1/3 and ½ hp.

Carrier Air Conditioning Company Div, Carrier Corporation, Syracuse 1, New York.

DUST COLLECTOR

Lack of moving parts and need for only a min of floor space characterize this wet type dust collector, cited as providing max efficiency in cleaning air streams. A compact unit, the Uni-Wash will remove dirt, dust, grindings, chips, fumes and vapors. No pumps or agitators are used in the air-washing process; contaminants are washed, scrubbed and fogged out of



the air stream and deposited as a wet sludge for manual or automatic removal.

DeVilbiss Company, Toledo 1, Ohio.

GAS, OIL FURNACES

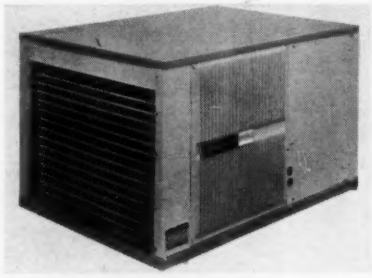
Two new gas and oil models, each available in four sizes, have been added to this furnace line. Designated Victorgas and Victoroil Fin Deluxe, units will incorporate new forced warn air features. Heat sensing control is cited as detecting temperature changes rapidly and automatically adjusting the burner flame to meet heating requirements. Other improvements available are a dual speed blower for controlling cool air drafts during early and late blower operating stages and a five-sided radiator.

Gas model is rated at 100,000, 125,000, 150,000 and 175,000 Btu/hr input and the oil unit at 84,000, 112,000, 135,000 and 150,000 at bonnet.

Hall-Neal Furnace Company, 1322 N. Capitol Ave., Indianapolis, Ind.

2-TON HEAT PUMP

Similar in appearance to 2½- and 3-ton self-contained units, the 2-ton Weathertron operates on 230 volt and



is available in single-phase only, since it was designed primarily for residential use. Weighing little more than 300 lb, it is adaptable to a wide range of locations, including slab, suspended or roof-top installations.

Mechanical features include a high-speed full hermetic compressor, direct-drive propeller type outdoor fan and quiet centrifugal indoor fan. Two driers are utilized, so that one is always in the refrigerant circuit, whether the unit is heating or cooling. All fan and motor bearings are permanently lubricated and draw-through coil construction reduces dirt and debris in the cabinet and minimizes effects of high winds.

General Electric Company, Central Air Conditioning Dept, Tyler, Texas.

VALVES, LIFT FITTINGS

Designed for low-pressure vapor and vacuum steam heating service, Series M600S radiator supply valves have a seamless Sylphon bellows to enclose steam throughout the entire length. Packless and tight against loss of vacuum, valves are available in angle, left-corner, right-corner and straight-way body models. Max pressure is 35 psi.

Spring-packed valves, Series MIO, have a min pressure of 60 psi and have application in hot water heat-

NEVER BEFORE an Oil Burner Control Like This!

KWIK-SENSOR

by

WHITE-RODGERS

ik-Sensor uses a new flame detector that makes possible first practical burner-mounted control. Kwik-Sensor can applied by the manufacturer to any domestic oil burner minutes . . . no adjustments or relocation of the flame tector are necessary, even though the burner may be ed in different types of furnaces or boilers, having vari- s types of combustion chambers.

Fast, Simple Installation

The Kwik-Sensor flame detector need only be positioned to pick up the radiant rays of the oil flame. The primary control can be mounted in or on the burner, in the furnace or boiler vestibule, or in any convenient spot. No special engineering required.

Instantaneous Response

Unlike heat-sensing control elements that require a time interval to respond, the Kwik-Sensor is a flame-sensitive resistor which reacts *instantly* to flame ignition or extinction. It responds *only to the radiant rays from the oil flame.*

New Flame Detector Location

The Kwik-Sensor flame detector is mounted at the blower end of the burner assembly—away from the flame area. Here it operates in a clean, cool stream of air—unaffected by soot, dirt or heat, and where it does not disturb the primary air pattern or interfere with servicing of burner.

Complete Factory Wiring

Kwik-Sensor makes possible a *fully wired* furnace, burner or boiler unit . . . all quality controlled *in the factory.* This means production-line economies . . . simplified inventories . . . and the elimination of problems long associated with the many variables of in-the-field stack mounted control installations.

Write now for specifications, dimensions, wiring diagram, and additional facts.

Complete Control Package

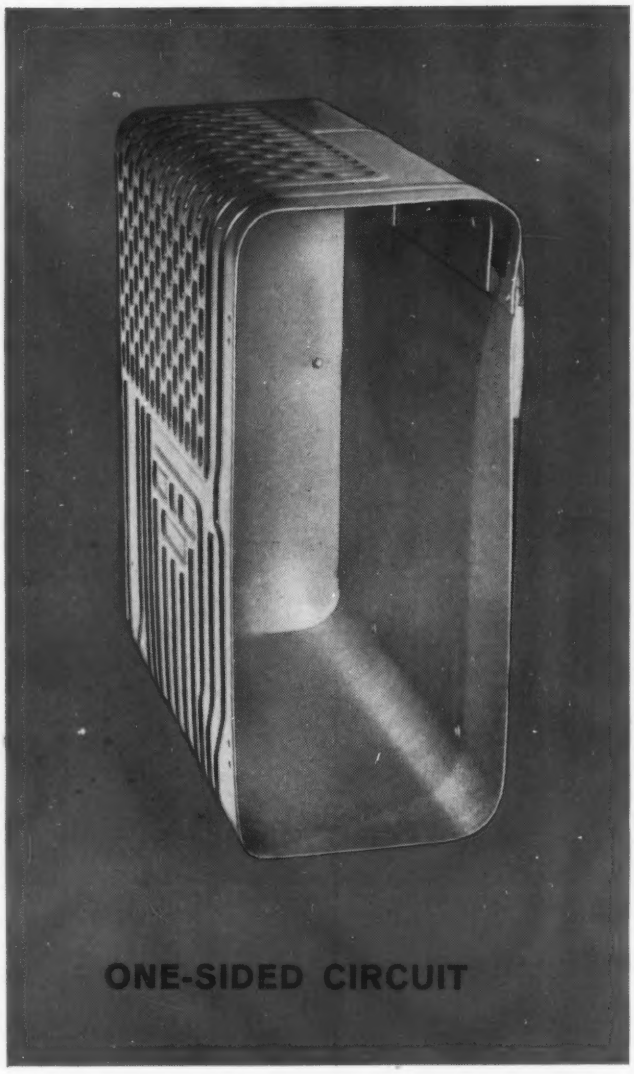
Kwik-Sensor combines with new D'LUXline Thermostat of straight-line design to provide a perfect control package for domestic oil burners.

WR

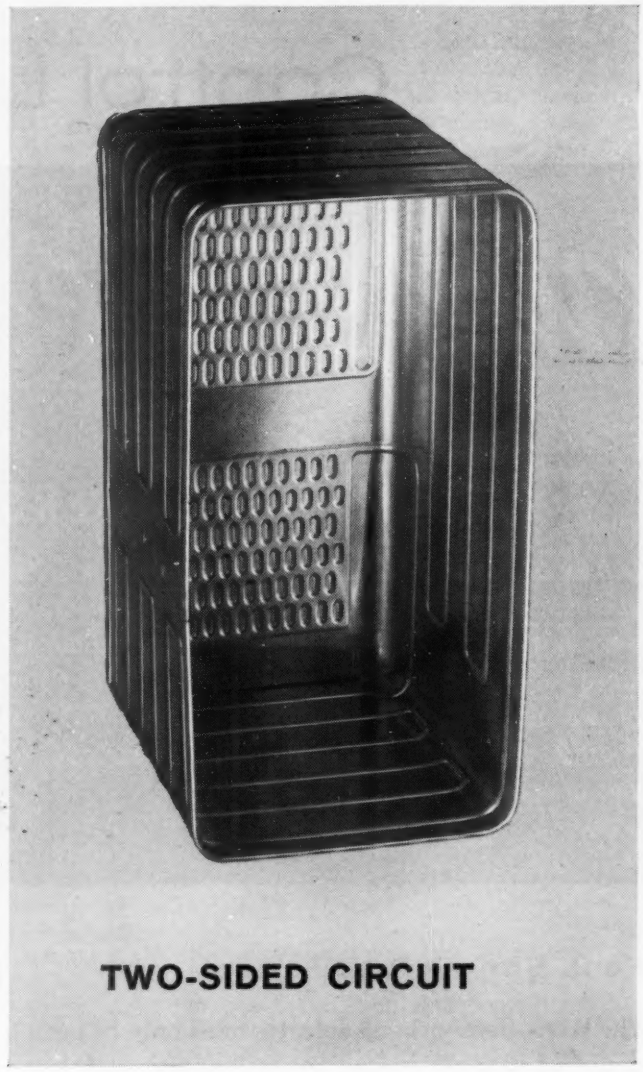
WHITE-RODGERS

St. Louis 6, Missouri
1209 Cass Avenue

Toronto 8, Canada
611 Gerrard St. East



ONE-SIDED CIRCUIT



TWO-SIDED CIRCUIT

REYNOLDS ALUMINUM ...the design you want

Aluminum Tubed Sheet, developed by Reynolds only a few years ago, is now a standard material for refrigerator evaporators, as well as for many products in other fields. And no wonder.

This lightweight, rustfree sheet with the "built-in tubing" gives the designer complete flexibility in his circuit planning. It eliminates virtually all outside tubing, and many joining problems. It's compact, efficient, and dependable.

With Reynolds Aluminum Tubed Sheet, you can specify the exact circuit you want, the exact type of Tubed Sheet you need . . .

One-Sided Circuit—with passages expanded on just one side, leaving the other side flat.

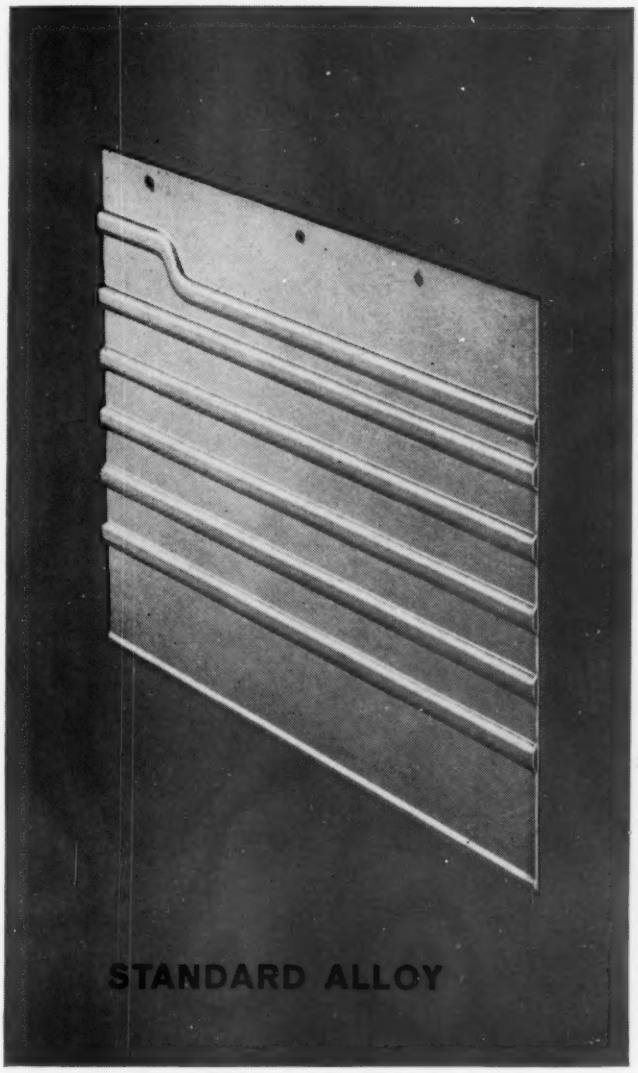
Two-Sided Circuit—with passages expanded on both sides of the sheet, providing larger tubing.

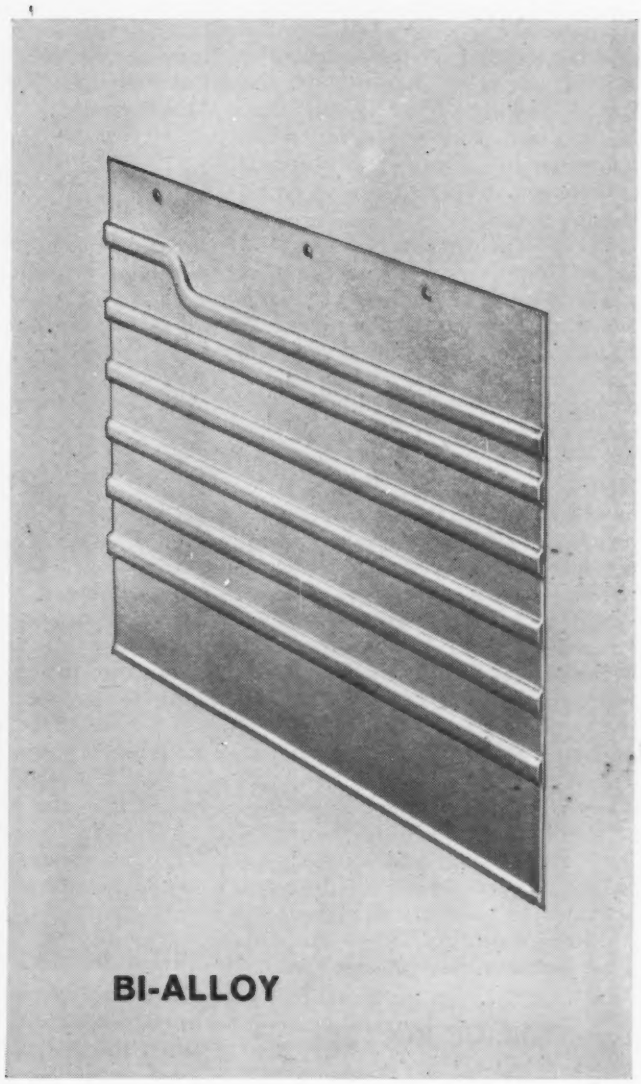
Standard Alloy—with both layers of the bonded "sandwich" sheet of the same aluminum alloy . . . this is the sheet most widely used by appliance manufacturers.

Bi-Alloy—with one or both layers of the bonded "sandwich" of an extra-strong alloy for surfaces that receive added wear, or where extra strength is required by product use.

Both Reynolds Standard and Bi-Alloy Tubed Sheet are available in one-sided and two-sided circuits.

With Reynolds, you have the added assurance





TUBED SHEET™

...the kind you want

of years of experience in fabricating Aluminum Tubed Sheet, plus Reynolds extensive facilities.

You'll find most of the leading makes of refrigerators use Reynolds Tubed Sheet for evaporators, but the applications of this material do not end there. Its flexibility, compactness, and efficiency are going to work in aircraft, electronic cooling devices, vending machines, and missile components, to name just a few uses.

For details on the properties, characteristics of Reynolds Tubed Sheet, or on Reynolds fabricating facilities, call your local Reynolds office, or write: *Reynolds Metals Company, P. O. Box 2346-AP, Richmond 18, Virginia.*

Watch Reynolds new TV show "Harrigan & Son", Fridays, starting October 7; also, "All Star Golf", Saturdays, resuming October 15—ABC-TV. And on Sunday, October 16, be sure to see the exclusive showing of America's new 1961 cars on The National Automobile Show, direct from Detroit over CBS-TV, 6 to 7 P.M. EDST.

ing systems where a packed type design is preferred. A heavy spring is utilized to exert pressure on the molded packing ring to take up wear. To increase spring tension when compensation for higher pressures is desired, a manually adjustable spring housing is used.

Using a thermostatic trap and radiator supply valve in a single unit, a double service valve has been introduced for use chiefly in one-story buildings and basements where the steam supply main is run along the ceiling with down-feed risers to radiators. Unit serves as both supply valve for the radiator and drip trap for the down-feed riser. Steam is admitted to the radiator by the valve member, which is a quick-opening, non-modulating type, using a spring-retained packing ring.

Lift fittings for use with vacuum systems of steam heating where condensation is to be lifted to a higher level, designated Series M24, are made of a single casting of close-grained gray iron. Fittings range from ¾ to 4 in. Sizes from ¾ to 2 in. have screwed connections for both inlet and outlet and sizes from 2½ to 4 in. have flanged inlet and screwed outlet. Companion flanges and bolts are provided as standard equipment.
Modine Manufacturing Company, 1500 DeKoven Ave., Racine, Wisc.

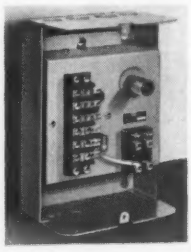
ICE STORAGE BIN

Three models of an aluminum exterior ice storage bin for use with automatic ice machines have been introduced by this company, and have

storage capacities of 250, 400 and 600 lb of ice. An internal frame of heavy-gauge welded steel supports the entire ice weight and machine section. No wood is used anywhere in the structure, eliminating warping, rotting and sagging. To retard ice meltage, three in. of low "K" factor glass fiber insulation is used on the bottom and two in. on the walls. Exterior shell is vapor sealed. Insulated and gasketed doors provide access to the ice.
Roy Follett Corporation, Phillipsburg, New Jersey.

FLOATLESS LEVEL CONTROL

Developed primarily for use on applications involving liquids of medium to high specific resistance (up to 12.5 megohm), this high sensitivity electronics floatless liquid level control, Type 50-201, is cited as incorporating several design features making it readily adaptable to an extended range of installations.



Fail-safe operation is assured by wiring to the terminals for either direct or inverse operation. Sensitivity is determined by the value of a fixed resistor mounted on the terminal strip, and selection of the resistor is based upon the specific resistance of the liquid to be controlled.
B/W Controller Corporation, 2200 E. Maple Rd., Birmingham, Mich.

THERMOSTAT

For control of two-stage electric heat in residential installations, this modulating thermostat is cited as offering great flexibility. By controlling both circuits of a two-stage system, it permits one low-wattage circuit to provide heat during cold weather, eliminating "hot spots" near the heating unit and reducing wall streaking caused by rapid air convection.
Mears Electric Controls, Inc., Beaverton, Ore.

UNDER-EAVES VENTILATOR

New design of Model 624 is cited as offering 11 to 17% greater free area than previous under-eaves (soffit) vents. Two sizes, 16 x 4 and 16 x 8 in., feature all-aluminum construction, a heavy, embossed margin for rigidity, round corners and ⅛-in. openings.
Leigh Building Products Div, Air Control Products, Inc., Coopersville, Mich.

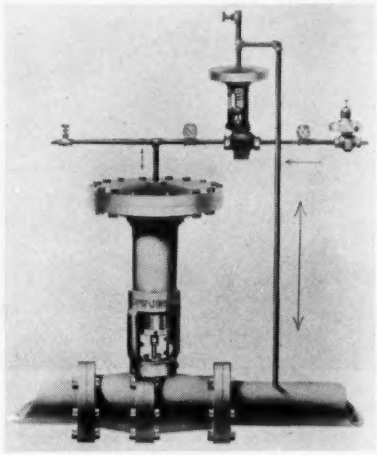
ELECTRIC FURNACES

Housed in compact jackets, these new furnaces are being manufactured in capacities of 10, 15 and 20 kw, equivalent respectively to 34,130, 51,195 and 68,260 Btu/hr. Optional two-speed blower provides air handling capacity for installations in which summer air conditioning is an important requirement. Highly flexible controls, which cut in heating elements in banks of five kw each, meet electric utility requirements and permit revision of operating sequences in the field to meet individual requirements.

Factory-wired with the 15-kw furnace is a 10-kw first stage, incorporating a 30-sec delay between the two 5-kw elements in this stage, and a 5-kw second stage. Manipulation of wire jumpers can create other sequences.
Rheem Manufacturing Company, 7600 S. Kedzie Ave., Chicago 52, Ill.

REDUCING VALVE

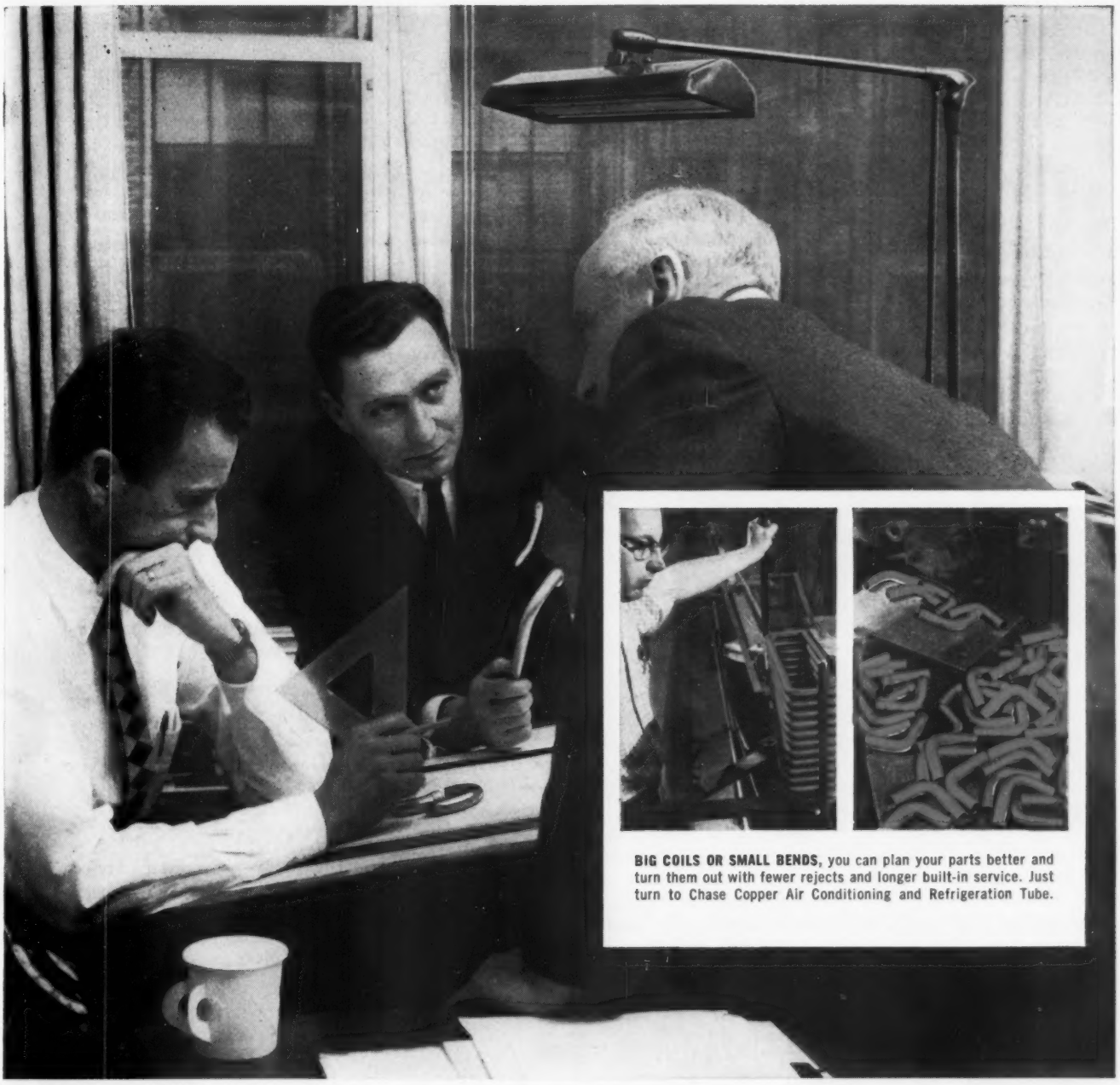
Now available in four and six-in. sizes, this sliding gate and plate pressure reducing valve, air-operated, has capacity of 50,000 lb of steam per



hr or 2500 gpm of water. Used to reduce pressure wherever large capacities, accurate control and tight shut-off are required, the system is suitable for pressures to 250 psi and temperatures to 500 F. Main valve is available in ductile and cast iron, flanged. Featured are sliding gate and plate seats, lapped to lightband flatness. Seats are self-cleaning and self-lapping to give tight shut-off and min maintenance.
OPW-Jordan Corporation, 6013 Wiehe Rd., Cincinnati 13, Ohio.

AXIAL FLOW BLOWERS

Range of sizes of this line of axial flow blowers for heating, ventilating and air conditioning applications is quite extensive, covering most industrial requirements. Blowers will handle from 1000 to more than 500,000 cfm with pressures from atmospheric to ten in. water static pressure, with single-stage units. Sizes range in 12 in. diam in the fixed blade design and



BIG COILS OR SMALL BENDS, you can plan your parts better and turn them out with fewer rejects and longer built-in service. Just turn to Chase Copper Air Conditioning and Refrigeration Tube.

You plan better with Chase® Copper Tube!

Fittings, Headers, Coils and other parts. Wherever you use copper tube in fabrication of parts, you'll find you can plan better if you turn to Chase® Copper Air Conditioning and Refrigeration Tube. You can get extra-long lengths of Chase Tube shipped on the new Disposable Reel—save space, time, manufacturing costs. And the tube itself is carefully tested to assure soundness. Chase expert metallurgy means you're getting tube that withstands severest manufacturing stresses without cracking or pinholing.

There's a Chase warehouse or sales office in the cities listed at right, ready to serve you.

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BRASS & COPPER CO. Waterbury 20, Conn.
Subsidiary of ***Kennecott Copper Corporation***

THE NATION'S HEADQUARTERS FOR **ALUMINUM • BRASS BRONZE • COPPER • STAINLESS STEEL AND FORGINGS**

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CITY_____ ZONE____ STATE_____

from 14 to 120 in. diam in blade retention designs. Standard hub diam available are in various sizes from 14 to 40 in. Engineered drives include belt, coupling or direct drive types. **Benson Manufacturing Company, Commercial Blower Div, Kansas City 27, Mo.**

PIPE REPAIR SYSTEM

Offering the advantage of thermosetting epoxy resins, this pipe repair system can be used on any diam pipe operating at pressures up to 100 psi. Although developed primarily as a means of repairing gas transmission and distribution lines without use of open flame and without entirely removing the line from service, this technique can be used for liquid piping repairs, as well as for joining and patching plastics pipe. Epoxy used is "Scotchcast" electrical resin No. 4 and is not affected by gasoline, fuel oil, crude oil or other hydrocarbons and resists most chemicals. Practical operating temperatures of the resin are limited by extremes of pressure and increased corrosive action at higher temperatures, however, the epoxy itself will withstand continuous operating temperatures in excess of 200 F.

Using application techniques developed in electrical cable splicing, the repair system utilizes a pressure hand gun to force the epoxy fluid into a simple tape mold, through a specially designed injection fitting. Resin is forced into the mold at approxi-

mately 100 psi pressure, hardens in 30 min and is completely cured in less than two hr.

Minnesota Mining and Manufacturing Company, 900 Bush Ave., St. Paul 6, Minn.

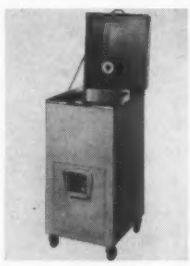
ROOF VENTILATORS

Horizon Line power roof ventilators are available with a choice of three interchangeable discharges: standard straight-through, decorative straight-through and mushroom. Low silhouettes, nylon damper bearings and aerodynamically-designed fan blades are among features of the units. Cited as making them chatter and leak-proof and light-tight is a combination of magnetic damper lock, damper design and rubber seal. Motors are direct-connected to the fan shaft. Discharge sections are hinge-connected to fan housing for safe accessibility.

Ten fan and twelve motor sizes cover a capacity range from 600 to 51,000 cfm. Construction is all-welded heavy gauge steel with aluminum dampers as standard and aluminum or stainless steel construction optional. **L. J. Wing Manufacturing Company, 140 Vreeland Mills Rd., Linden, N. J.**

MOBILE TEST CHAMBERS

Designated Hi-Lo Tempmobiles, mobile environmental test chambers are



available in three sizes and temperature ranges from −22 to 160 F. All temperatures are thermostatically controlled. Interiors are of stainless steel with three-in. cork and glass fiber insulation. Interior capacities range from ten to fifty gal.

Compressor is hermetically-sealed and spring-mounted, and refrigerant lines have vibration eliminators. Units roll on heavy-duty casters.

Hudson Bay Company, 3070 W. Grand Ave., Chicago 22, Ill.

STRAINERS, TRAPS

Introduced for steam, water and gas service, "Y" type strainers for pressures up to 150 psi are available with a choice of basket perforations and are suited for air conditioners, sterilizers, oil lines, gas and compressed air lines and other applications where protection of equipment from dirt is a requirement. Series M78 strainers are designed to provide a high ratio between the free area of pipe and the free area of strainers in order to assure a low pressure drop through the strainers and large dirt collecting capacity. Strainers with screwed body connections are provided with a removable basket consisting of a brass screen with 225 holes (diam 0.045 in.) per sq in. Max working pressure is 150 psi for the screwed body type units and 125 psi for flanged body types.

Thermostatic traps for radiation and convectors, available with diaphragm or bellows type elements are designated M5, M7 and M7-M. Three standard sizes and five body models are available for service on most types of radiators, convectors, drip points, steam-using equipment and other applications. Operating pressure for the valves is from 15 to 25 psi.

Also introduced is a completely new line of traps for process steam applications ranging from 15 to 150 psi. Newly designed float type Series M27 drip trap has a max pressure of 15 psi but is available with thermostatic air by-pass and also without the thermostatic element and air by-pass for use where manual venting or external air by-pass are specified.

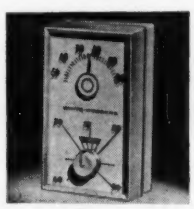
Series M78 thermostatic traps have a max pressure of 150 psi and will provide automatic, quiet and complete discharge of air and condensate from process steam equipment. Available in angle pattern only, it has body and cover made of brass.

Series M80 float type drip traps are applicable in the process field where pressures range to 150 psi. Available in three sizes with ¾, 1 and 1¼-in. connections, traps are provided with interior mechanisms for five different pressure ranges.

Modine Manufacturing Company, 1500 DeKoven Ave., Racine, Wisc.

THERMOSTAT

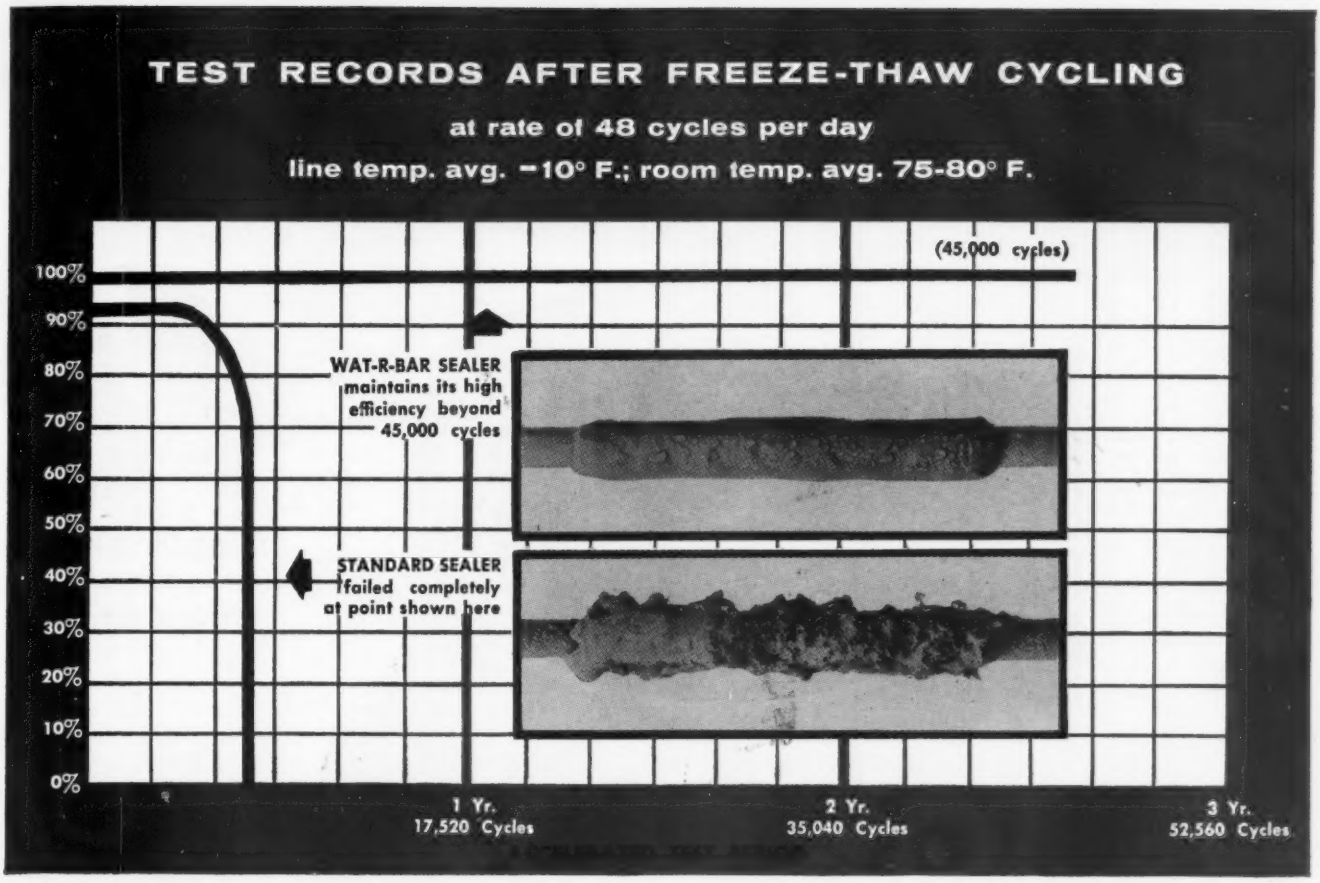
Another new thermostat, styled in the Straight-Line Look, has been introduced by this manufacturer. Designated Mainline, it is a vertically styled heating thermostat with sealed mercury contacts for protection against dirt, dust and corrosion. Fixed heat anticipation, to match all primary controls, is achieved through removable carbon disk resistors. Setting is of the knob-type, with a large and easily-read dial. Range is from 55 to 90 F, with a differential of ½ to 1½ F.



White-Rodgers Company, 1209 Cass Ave., St. Louis 6, Mo.

WEATHERSTRIP MATERIAL

Color uniformity and absence of stains and discolorations from one end of a coil to the other are features of this new bronze weatherstrip, also cited as being free of waves and buckles and unrolling flat for easy feeding and roll-forming. Surfaces contain no scallops or striations. Choice of alloy, temper width and gauge are a matter of customer preference and specifica-



45,000 freeze-thaw cycles and still going strong!

Wat-R-Bar® has this test-rated sealing record

Many years of operation have been capsuled by tests to guide those who want a sealant that keeps on sealing through the years. Our test cycles were one hour in duration—30 minutes freezing, 30 minutes thawing at ambient temperature. Pilot tests proved that shorter cycles were insufficient to tell the true story of the material's resistance to freeze-thaw.

When you specify ***Wat-R-Bar*** you know you have the best. Only with ***Wat-R-Bar*** do you have the time-proved evidence of lasting resistance to water vapor, high humidity, and temperature extremes.

When you seal . . . seal with assurance.

We will be glad to furnish certified proof that *Wat-R-Bar* has completed more than 45,000 freeze-thaw cycles over a three-year period of accelerated tests. Write Dept. R-21.

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3790 CHOUTEAU AVE. • ST. LOUIS 10, MO.

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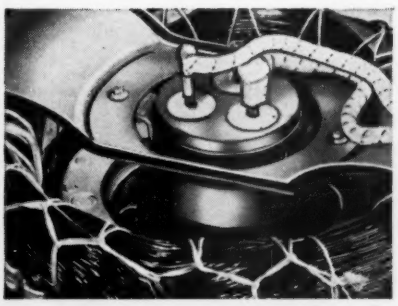
STARTS HERE...

Copelaweld features

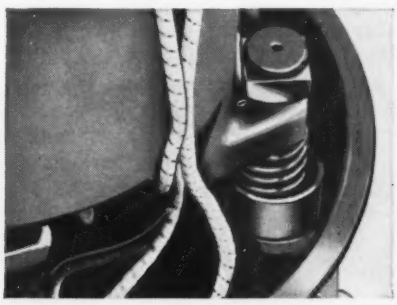
pack more value than ever into air conditioners and heat pumps

4 cylinders • 1750 R.P.M.
2½ H.P. • 3 H.P. • 3½ H.P.
4 H.P. • ...and now 5 H.P.



INTERNAL, INHERENT MOTOR PROTECTION

An industry first! Copelaweld inherent protection is internal, hermetically sealed . . . cannot be tampered with, by-passed or changed. No pilot circuit required . . . no current or temperature-sensitive devices outside the compressor shell. Close proximity of protector to motor provides superior locked-rotor and running protection and is independent of external ambient conditions.



QUIET, VIBRATION-FREE OPERATION

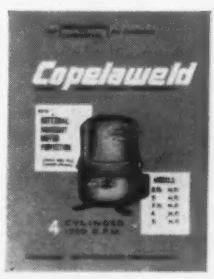
A new standard of smooth, quiet operation made possible by an unmatched combination of features: 1750 R.P.M.; four cylinders, 90°V, one discharging each 90° of rotation; and cast-in discharge muffler. Internal spring mountings isolate sound and vibration within the compressor shell. No need for costly suction and discharge vibration absorbers in most installations.

ENGINEERED FOR LONG DEPENDABLE LIFE

Lasting dependability, traditional with all Copeland products, is built into Copelaweld motor-compressors. Contributing to long life expectancy are: aluminum connecting rods for low reciprocating weight; valve plates of proven design; positive lubrication to all rotating bearing surfaces; and generously-sized, high-torque motors. Equipped with oil sight glass and drain plug.

Welded Hermetics,
Accessible Hermetics
or Belt-Driven...
COPELAND has
what it takes!

For complete specifications and performance data on the Copelaweld line of "4U" motor-compressors, request Bulletin No. 6026. Call or write direct.



SINCE 1918 **Copeland** REFRIGERATION

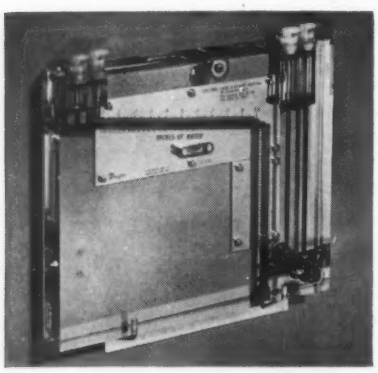
Manufacturers of performance-proved motor-compressors and condensing units for air conditioning and refrigeration

CORPORATION, Sidney, Ohio

tion, but the manufacturer recommends that material should be ordered to the exact width for any specific application. Alloys normally used are commercial bronze (90% copper, 10% zinc), jewelry bronze (87.5% copper, 12.5% zinc), red brass (85% copper, 15% zinc) and cartridge brass (70% copper, 30% zinc).
Chase Brass & Copper Company, Waterbury 20, Conn.

MANOMETERS

Designed for use with pitot tubes and in flow measurement, inclined-vertical manometers in this line are avail-



able in single and double column styles, stationary or portable, in various ranges up to 23 in. of water. They are cited as being accurate within ±1%. Fabricated from solid blocks of clear acrylic plastics, they are virtually unbreakable.

Only ground glass spirit levels are used for max accuracy and sensitivity. Rapid shutoff type molded nylon gauge connectors are standard. Portable models include magnetic mounting clips as well as flat surface leveling mounts.
F. W. Dwyer Manufacturing Company, P. O. Box 373, Michigan City, Indiana.

HEAT PUMP

Based upon the reversible heating-cooling cycle principle, the Electro-Flo heat pump is designed to provide dust-free, controlled-humidity comfort and is offered for installation only with remote condensing units. Condenser section is installed outdoors for economy of space, greater quiet and more effective, trouble-free defrosting.

Indoor section consists of a heating-cooling coil and a blower-filter unit, which can be arranged for vertical, counterflow or horizontal installation. An optional electric furnace for supplementary resistance heating can be incorporated into the assembly.

Cooling capacity is 36,000 Btu/hr at 95 F, heating capacity 37,000 Btu/hr at 45 F. Optional auxiliary heat capacities extend to 71,715 Btu/hr.
Stewart-Warner Corporation, Lebanon, Ind.

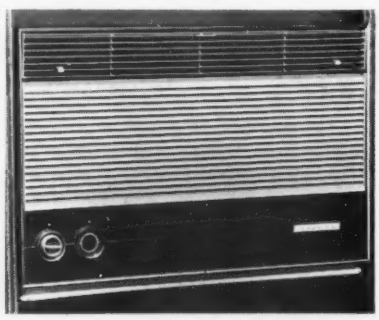
SADDLE VALVE

Primarily a brass fitting, contoured to "saddle fit" most tube sizes for charging, discharging and testing, this access saddle valve may be installed permanently in the factory to provide a hermetic port for later field servicing. Valve is attached to any convenient portion of the suction or discharge line by silver brazing and becomes an access valve only when the unit requires servicing. At this time, a piercing needle is inserted and a control valve attached.
Watsco, Inc., 1020 E. 15th St., Hialeah, Fla.

ROOM AIR CONDITIONERS

Four basic lines introduced for 1961 are: a Ready-Mount with sliding translucent wing panels in a compact, 11-in. deep cabinet; the Sceptre series, only 14 in. deep and delivering up to 9600 Btu/hr; Viscount, 24-in. deep models with a max capacity of 15,000 Btu/hr; and the Imperial (shown), a compact model delivering 20,000 Btu/hr. Sceptre, Viscount and Imperial series include four-way air deflection, two-speed fans and exhaust and ventilation settings. Rust-proof construction is a major feature of the line and all units are removable for servicing without breaking the window seal.

Ready-Mount is a 115-volt model delivering 5600 Btu/hr. Sound level is reduced and a single on-off and



thermostatic control is located on the front.

Two 115-volt models in the Sceptre series offer a choice of 7000 Btu/hr on 7½ amp or 9000 Btu/hr on 12 amp. 208 and 230-volt units produce 9600 Btu/hr of cooling.

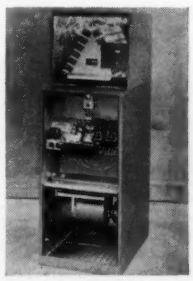
Offered in the Viscount series are 115-volt models which have capacities of 8500 Btu/hr on 7½ amp and 11,000 Btu/hr on 12 amp. 13,000 and 15,000 Btu/hr outputs are provided by the 208 and 230-volt models. Low noise levels indoors and out are achieved by Turbo-jet and Radiax fans. Slide-out chassis, lack of side louvers and front location of controls suit units for through-the-wall mounting.

470 cfm of air are handled by a centrifugal evaporator fan provided in the Imperial model, and a four-row condenser coil permits an output of 20,000 Btu/hr with power consumption of only 3000 watt.

Heat pumps to be offered by the manufacturer include a Sceptre series in 115 volt without supplemental strip heat and a 230-volt model with an additional 5500 Btu/hr of electric strip heat capacity; a Viscount series 230-volt unit giving 14,000 Btu/hr of cooling and adding strip heat of 6200 Btu/hr; and an Imperial model with 18,000 Btu/hr cooling. All heat pumps will have automatic defrost.
Carrier Air Conditioning Company Div, Carrier Corporation, Syracuse 1, New York.

ELECTRIC FURNACE

Manipulation of wire jumpers on Series 5000 electric furnaces (shown with front panel removed) permits revisions of operating sequences to cut in heating elements in banks of five kw each, to meet individual utility requirements. For example, the 15-kw furnace is factory-wired with a 10-kw first stage,



including a 30-sec delay between two 5-kw elements. Units are available in capacities of 10, 15 and 20 kw, equivalent respectively to 34,130, 51,195 and 68,260 Btu/hr. Shown on the furnace is a Rheemaire evaporator coil, and a two-speed blower is available as optional equipment for installations in which summer air conditioning is a requirement.
Rheem Manufacturing Company, 400 Park Ave., New York 22, N. Y.

AXIAL FLOW FANS

Blade retention system in these blowers allows each individual blade to rotate about its own hub axis, cited as minimizing bending and fatigue stresses. Blades are individually mounted on rubber pads. Fans are installed on in-line connections with existing duct work to eliminate elbows and off-sets normally required on centrifugal installations.
Commercial Blower Div, Benson Manufacturing Company, Kansas City 27, Mo.

Quiet...

WAGNER Polyphase Resilient Mounted Motors in ratings through 10 horsepower

Quiet, vibration-free performance is essential when motors are installed in areas where noise must be held to a minimum . . . in hospitals, churches, schools, office buildings, restaurants and similar locations where quiet is needed or wanted.

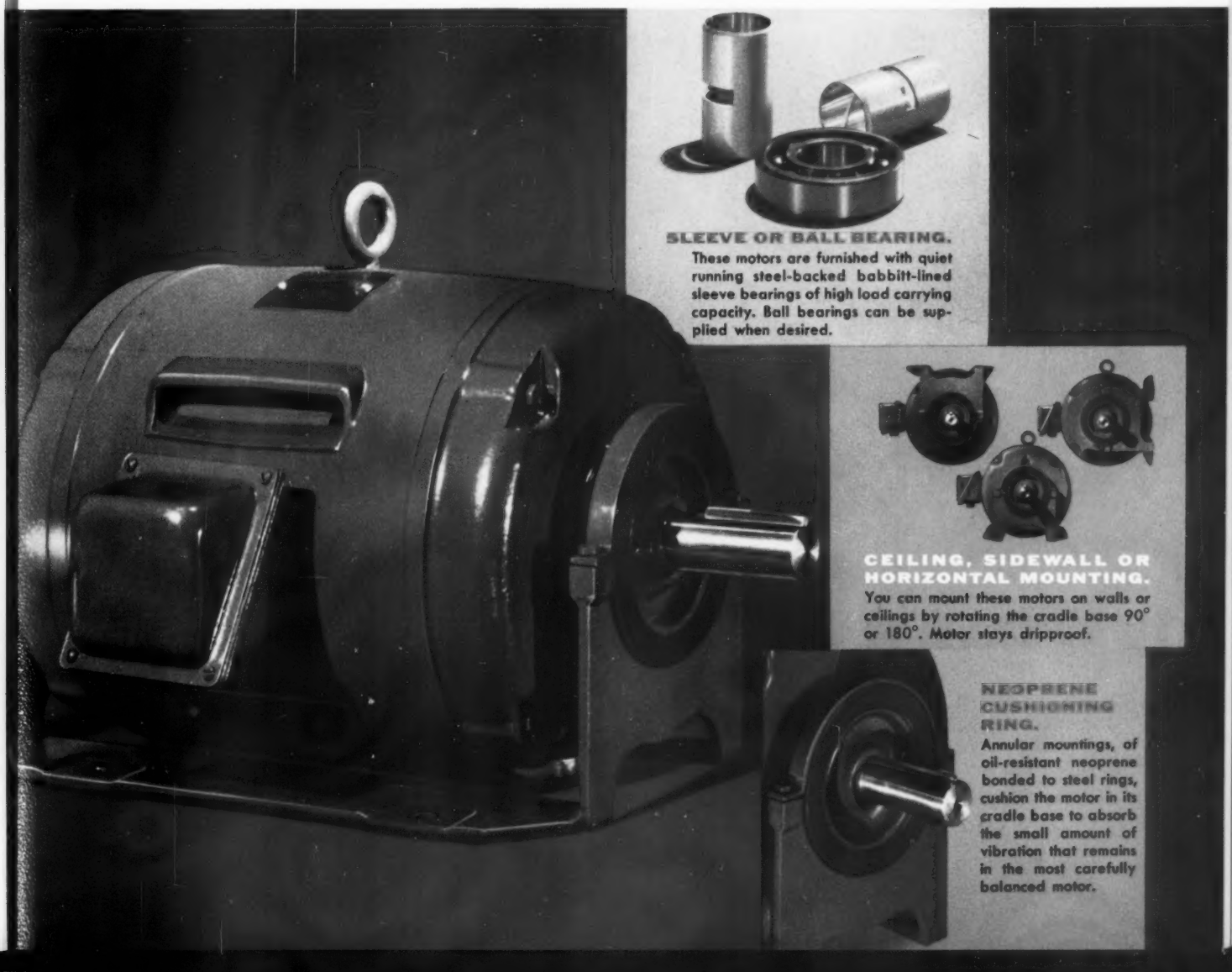
Such installations have created a need for larger polyphase motors that whisper while they work. Wagner has met this need by expanding its line of polyphase resilient mounted motors to include standard ratings through 10 hp.

You certainly have applications that call for a smooth running motor, cushioned by resilient mountings. To make sure they're quiet, specify Wagner Polyphase Resilient Mounted Motors. Only Wagner can provide an entire range of ratings through 10 hp.

Constant research and development have kept Wagner up front in electric motor design for more than 65 years . . . made the name Wagner one you can depend on in choosing electric motor drives.

Your nearby Wagner Sales Engineer can help you select the right motor to meet your requirements. There are Wagner branch offices in 32 principal cities.

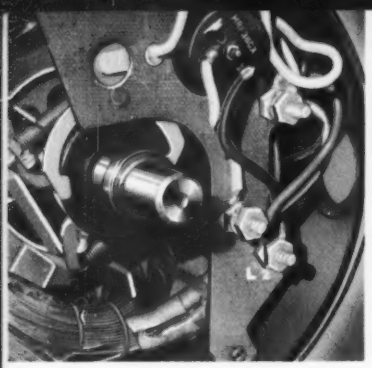
Wagner Electric Corporation
6400 PLYMOUTH AVENUE, ST. LOUIS 33, MISSOURI



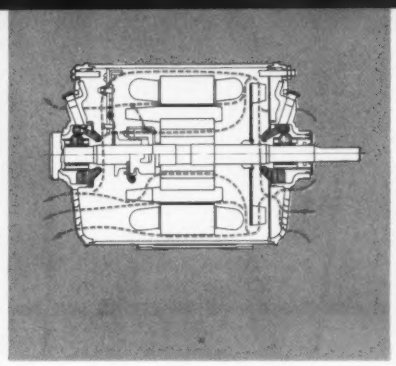
SLEEVE OR BALL BEARING.
These motors are furnished with quiet running steel-backed babbitt-lined sleeve bearings of high load carrying capacity. Ball bearings can be supplied when desired.

CEILING, SIDEWALL OR HORIZONTAL MOUNTING.
You can mount these motors on walls or ceilings by rotating the cradle base 90° or 180°. Motor stays dripproof.

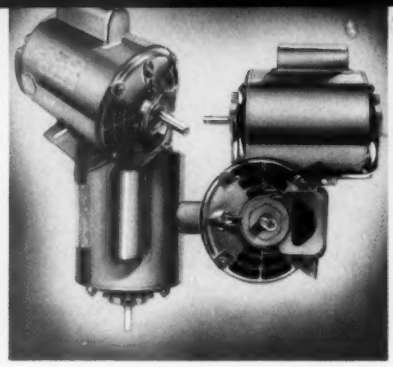
NEOPRENE CUSHIONING RING.
Annular mountings, of oil-resistant neoprene bonded to steel rings, cushion the motor in its cradle base to absorb the small amount of vibration that remains in the most carefully balanced motor.



Quick Break Switch. The starting winding is disconnected from the line by this Wagner designed switch . . . test proved to make more than a million breaks. (That adds up to two starts per hour for 50 years!)



Efficient Cooling System. The improved ventilating system used in these motors directs a large volume of air through the motor to effectively reduce temperatures and add to motor life. Cross section indicates direction of air flow.



All-Angle Operation. The sleeve bearing design, in fractional hp ratings, has a positive lubrication system that permits operation in any position . . . can mean important savings in motor costs to manufacturers.

Quick Connect Terminals. Brass tabs on terminal studs permit quick, easy connection of leads . . . cut wiring time to speed assembly line production. Simply press the lead receptacle on to the stud—a positive connection is assured.

NO STARTING PROBLEMS with WAGNER CAPACITOR-START MOTORS

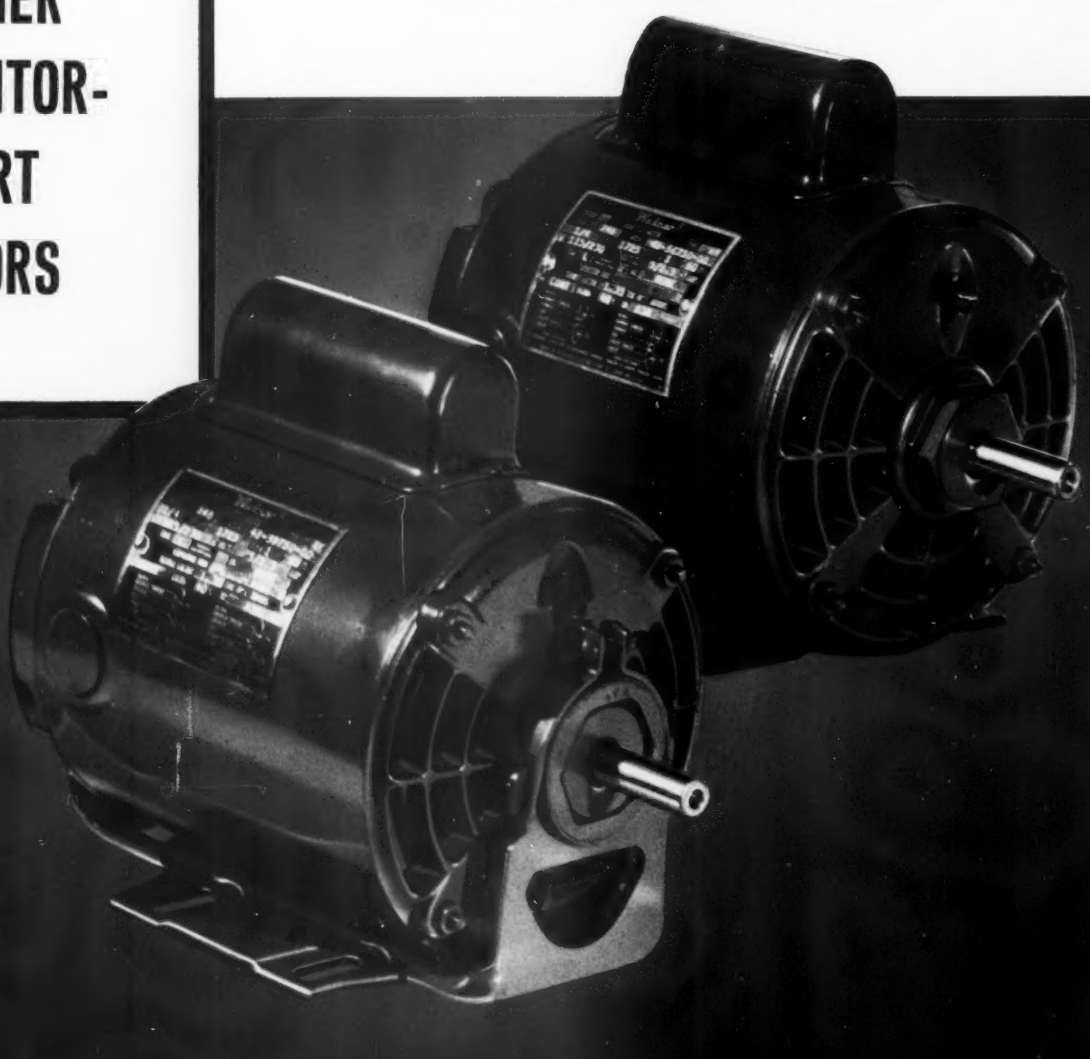
Pack more power into less space...give long troublefree service...are easy to hook up

Here are general purpose single-phase motors that have high starting torque and high pull-in torque. When used in the proper application and supplied with voltage close to their rating, they'll give positive starts every time. Troublefree operation is assured . . . thanks to the positive action of the Wagner governor mechanism and long life quick-break switch.

Wagner Type RK Motors pack more power into less space. Small enough to fit in tight spots, their ruggedness is built-in . . . permits direct mounting. And, sleeve bearing fhp models can be operated in any position. They are available in a range from 1/6 through 5 horsepower, with sleeve or ball bearings, and with rigid bases or resilient mountings.

Get these motors from leading motor distributors in your city, or from Wagner sales offices in 32 cities across the country. Your Wagner Sales Engineer will be glad to help you select the right motor for your application. Wagner Bulletin MU-217 gives full details on Capacitor-Start Motors.

Wagner Electric Corporation
6400 PLYMOUTH AVENUE, ST. LOUIS 33, MISSOURI



From the leader in air-cooled condensing

the new KRAMER UNICON-COMPRESSOR

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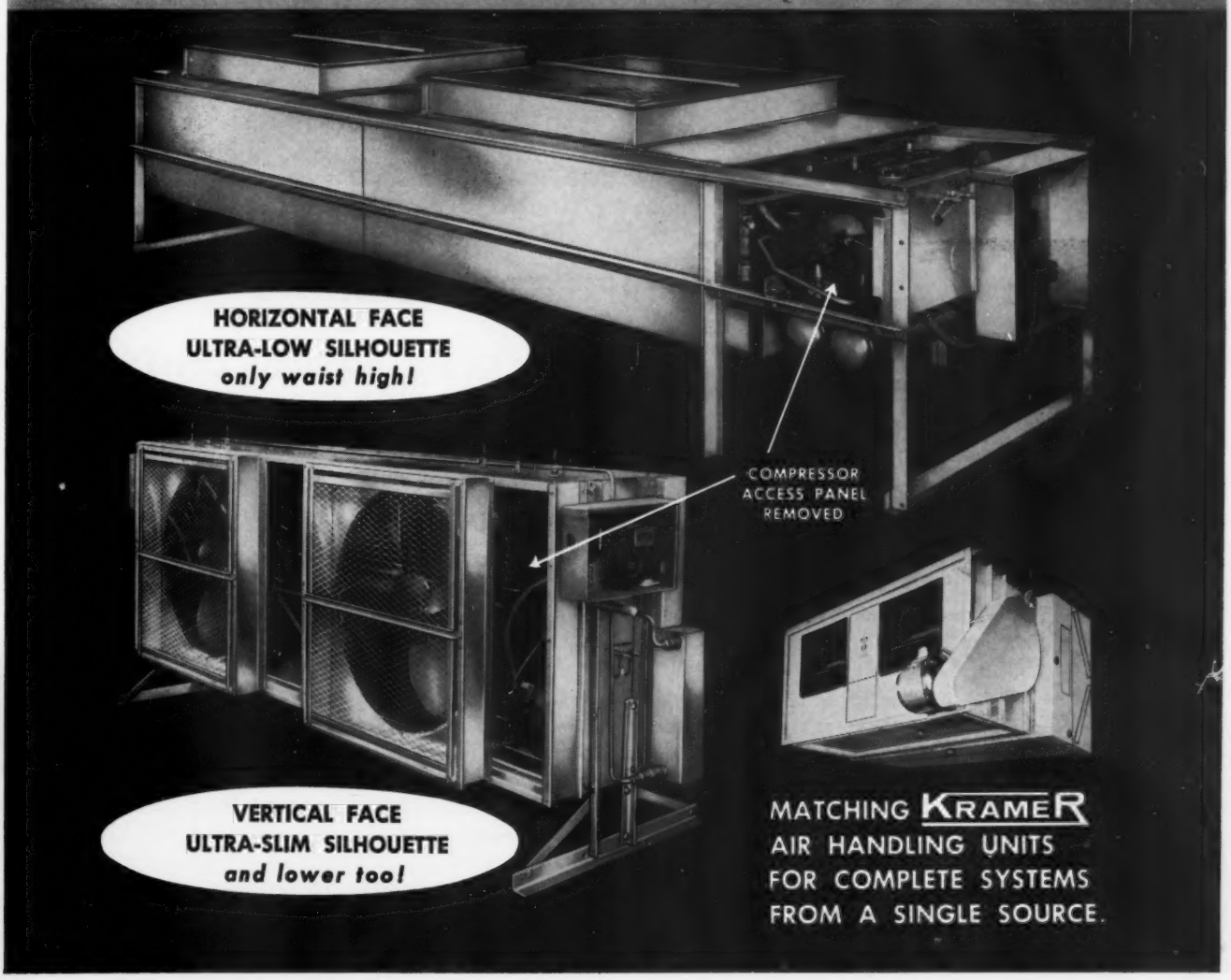

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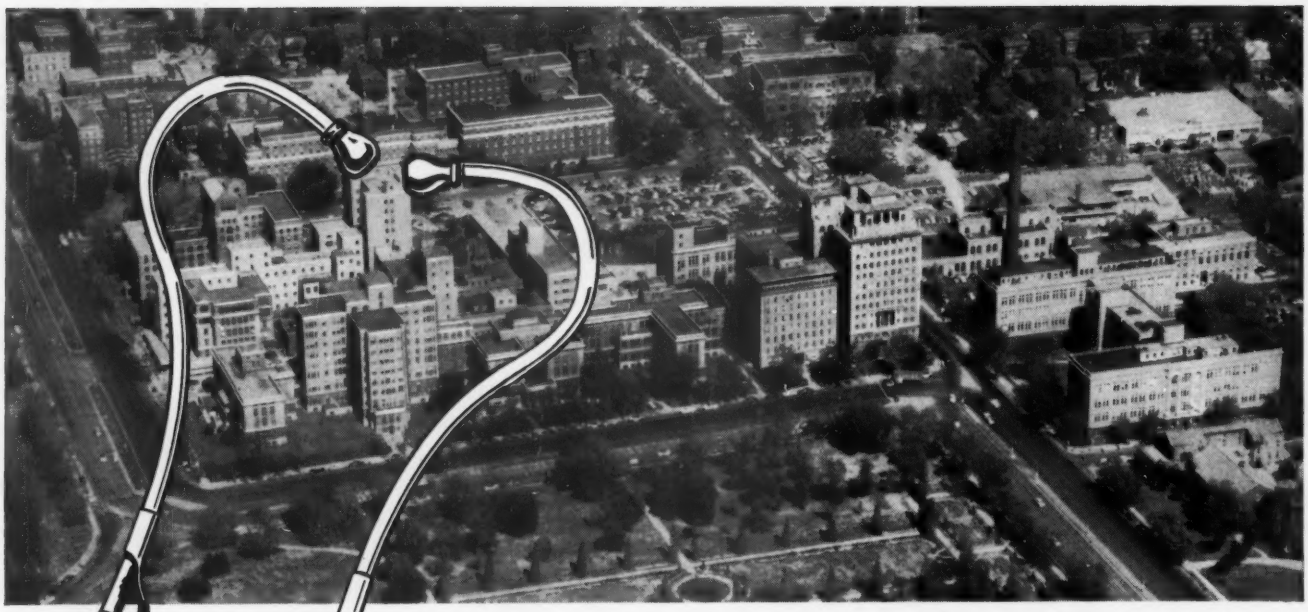

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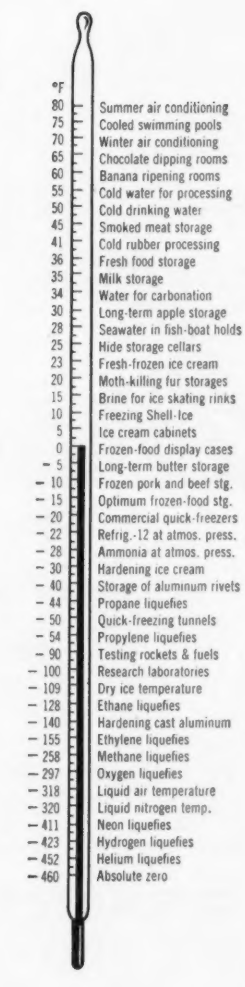

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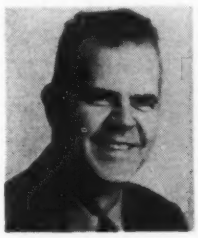
A simplified procedure for calculation of

Residential cooling loads



W. S. HARRIS
Member ASHRAE

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Aware of the need for a single procedure to estimate residential cooling loads, three trade associations (IBR, ARI, NWAHACA) appointed a joint committee to study those methods now used by various organizations in order to develop a common procedure that would be acceptable to the entire industry. Information from the ASHRAE GUIDE on heat gains and data on cooling loads compiled from 5 research houses at the University of Illinois provided the basis for the proposed cooling load calculating procedure, herein described, which approximated the measured maximum loads in each of the houses.

As the demand for residential air conditioning has increased, several independent approaches to the problem of calculating the design cooling load have been made with the result that each of the major trade groups interested in the residential cooling market has developed its own cooling load calculation procedure. Since the basic assumptions regarding design conditions are not the same for each of these procedures, it is apparent that the calculated design loads as determined by these procedures may not be in agreement. Such a condition is confusing to the prospective purchaser of cooling equipment and to those engaged in financing the construction of air conditioned homes.

The Federal Housing Administration requested that an effort be made to bring about greater agreement in the methods of calculating residential cooling loads. The Air Conditioning and Refrigeration Institute, the Institute of Boiler and Radiator Manufacturers and the National Warm Air Heating and Air Conditioning Association appointed a joint committee to study cooling load estimation methods to see if a common procedure could be developed which would be acceptable to the members of all three of these trade associations.

The National Warm Air Heating and Air Conditioning Association and the Institute of Boiler and Radiator Manufacturers have sponsored residential heating and summer air conditioning research under the terms of cooperative agreements with the University of Illinois Engineering Experiment Station for many years. During this period, the Association has built four Research Residences and the Institute has built two Research Homes in Champaign-Urbana. The analysis of cooling loads contained in this paper includes the results of investigations conducted in W. A. Research Residences Nos. 2, 3, and 4, the I-B-R Research Home and Hydronic Research House. Data collected in these houses were used as the basis of a proposed design procedure which would be acceptable to the entire industry.

All cooling load calculation

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procedures are basically for sensible load with allowances added for latent and internal loads. This paper deals with the sensible load only. It was assumed that an adequate design procedure should meet the following conditions:

A. Inside conditions: Inside design dry bulb temperature was assumed to be 75 F. This temperature was suggested since it is a commonly accepted comfort condition. It was further assumed that equipment selected on the basis of these design loads should be adequate to maintain indoor design temperatures within normal thermostatic control tolerances during a design day and at the same time operate more or less continuously during the daylight hours.

B. Outside conditions: It was concluded that the effect of daily temperature range on total load was sufficiently small that it could be neglected, and that the simplification of tabulated data was more desirable and valuable than was the inclusion of the additional information. Accordingly, it was decided that a daily outdoor temperature range of 20 F would be used regardless of the outside design dry bulb temperature.

The I-B-R Hydronic Research House, Figs. 1 and 2, was a combination masonry and frame, trilevel home, representative of modern construction. The house contained 10 rooms and 2½ baths. Total floor area, exclusive of garage and equipment room, was 1638 sq ft. The masonry wall on the first level was uninsulated and had a calculated heat transmission coefficient of 0.19 Btu/hr/sq ft/F. One inch of blanket type insulation was included in the frame walls on the second and third levels. The calculated coefficient of heat transmission of these walls was 0.12 Btu/hr/sq ft/F.

All windows, with the exception of one large window next to the front door, were single glazed. The ratio of window area to gross exposed wall area ranged from a low of 8% in bedroom No. 3 to a high of 55% in the living room. The average ratio was 18%.

Nearly all the ceilings in second and third level rooms were of the cathedral type. That is, the finished ceiling of the room was applied to the under side of the roof rafters. Two inches of insulation was installed above the ceiling and the air space above the insulation and below the roof sheeting was vented to the outdoors through slots 4½ in. wide running the full length of each eave soffit. The calculated coefficient of heat transfer for the combined ceiling and roof was 0.08 Btu/hr/sq ft/F.

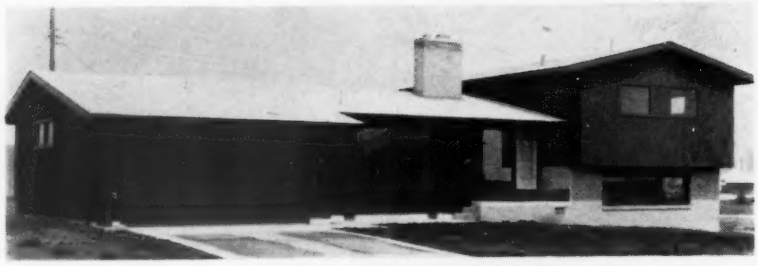
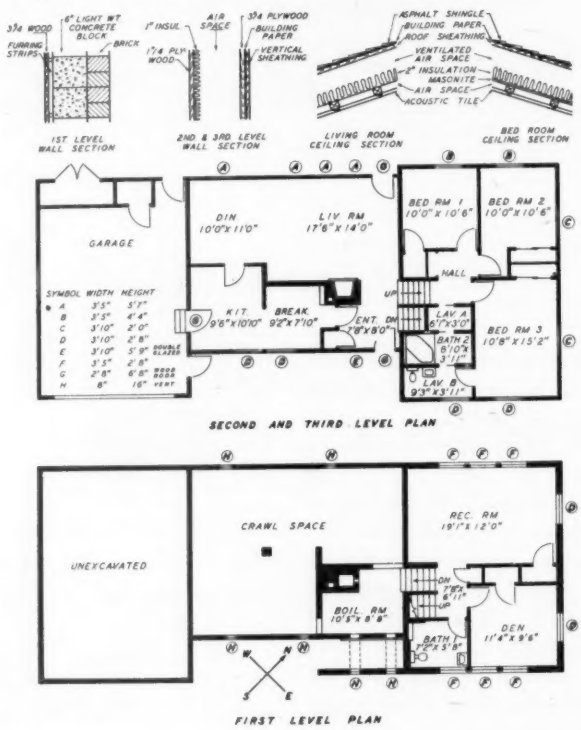


Fig. 1 I-B-R Hydronic Research House

Fig. 2 I-B-R Hydronic Research House, floor plan



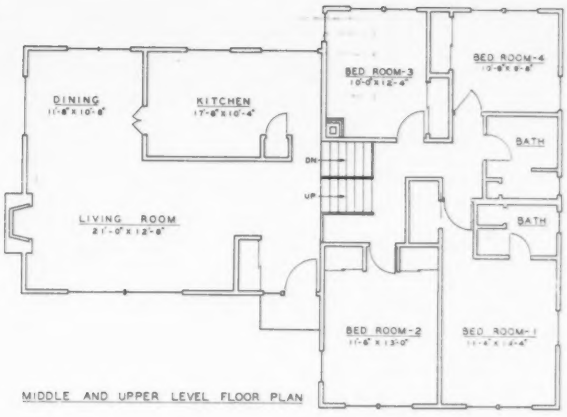
The I-B-R Research Home was a fully insulated, two-story brick veneer structure. The use of glass was conservative and the location of the house was such that the entire building was shaded a great deal of the time either by trees or surrounding buildings. A complete description of this house has been given in previous papers.[1,2]

W. A. Research Residence No. 2 was a one-story structure of frame construction with a large amount of glass exposure and with a full basement. The house was fully insulated with 3⅝-in. mineral wool insulation in the walls and 5 in. of mineral wool in the ceiling. A complete description of the house was given in previous papers.[3,4]

W. A. Research Residence No. 3 was a single-story, low cost home with a concrete slab floor. It was of frame construction and had a relatively large amount of glass area. The walls were uninsulated but the ceiling was insulated with 3⅝-in. batt-type mineral wool insulation. The house has been fully described in a previous paper.[5]

W. A. Research Residence No. 4 was a three-level structure of

Fig. 3 Warm Air Research Residence No. 4



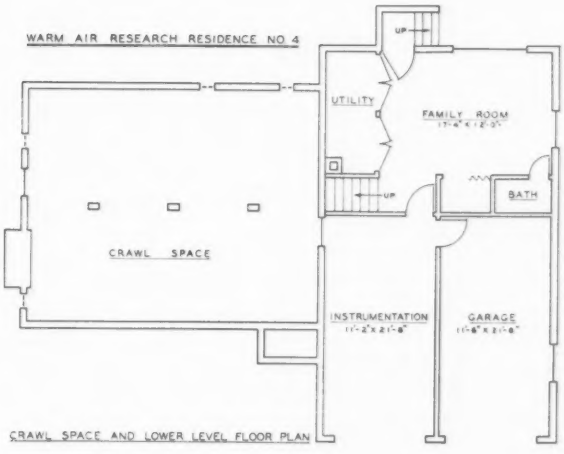


Fig. 4 Warm Air Research Residence No. 4, floor plan

frame and masonry construction. The total floor area was 2400 sq ft of which 2100 sq ft were used for living areas. A view of the residence from the southwest is shown in Fig. 3 and a floor plan is shown in Fig. 4.

The lower level exterior walls were concrete block with no interior or exterior finish other than paint. The calculated coefficient of heat transmission, U, for this wall was 0.52 Btu/hr/sq ft/F. The windows were weather stripped but were not equipped with storm sash during the cooling season.

The middle level and upper level exterior wall sections were identical and consisted of cedar shingles, 15/32-in. insulating sheathing on 2-in. x 4-in. studdings, 2-in. glass fiber blanket insulation with vapor barrier attached and ½-in. foil-backed gypsum board on the interior. The calculated heat transmission coefficient of this wall section was 0.08 Btu/hr/sq ft/F. All windows on these two levels, with the exception of a sliding glass door in the dining room, were single glazed. As shown in Fig. 3, the 3-ft roof overhang provided shade for all windows on the upper level and for all middle level windows with the exception of those on the west. The ceilings on the middle and upper levels consisted of ½-in. foil-backed gypsum board on 2-in. x 6-in. ceiling joists, and 4-in. glass fiber blanket insulation with vapor barrier attached. The attic spaces were provided with vents for natural ventilation.

The five houses presented a wide variety of constructions. The I-B-R Research Home and W. A. Research Residence No. 2 were fully insulated and tightly constructed houses. W. A. Residence No. 3 was the opposite with a minimum of insulation. The present I-B-R Hydronic Research House and W. A. Research Residence No. 4 incorporate features of all three of the other houses with some wall sections well insulated while other walls are completely uninsulated. Cooling load information from the 5 houses presents a basis for comparison of cooling load estimation procedures.

Heat flow rates were measured by means of heat flow meters installed in the walls and ceilings. Fig. 5 shows the outdoor dry bulb temperature and the heat flow rates through three walls and one ceiling of W. A. Residence No. 4 on a near-design day for the period from 6:00 AM to 12:00 midnight CST. The curves show the effects of wall construction and orientation on the heat flow. The heat flow rate through the uninsulated lower level concrete block east wall increased rapidly after 7:00 AM because of the direct exposure to the morning sun. The peak heat flow rate of 10.5 Btu/hr/sq ft occurred at 12:00 noon after which the heat flow decreased. Maximum heat flow through the upper level east frame wall was recorded at 9:00 AM. Shading provided by the roof overhang caused a decrease after 9:00 AM. The heat flow through the west frame wall on the middle level reached a peak at 6:30 PM. The maximum heat flow through the middle level ceiling occurred between 2:00 and 3:00 PM.

Fig. 6 represents the measured hourly transmitted sensible cooling load (not including internal load) for each level of the I-B-R Hydronic Research House and for the house as a whole. The maximum hourly sensible heat gain for the house was about 20,000 Btu/hr and occurred at about 4:00 PM. The maximum sensible loads and times of occurrence by levels were 3,600 Btu/hr at 9:00 AM for the first level, 9,700 Btu/hr at 5:00 PM for the second level, and 7,800 Btu/hr at 1:00 PM for the third level.

From the preceding it is apparent that the peak heat flow rates through the various elements of the house did not occur simul-

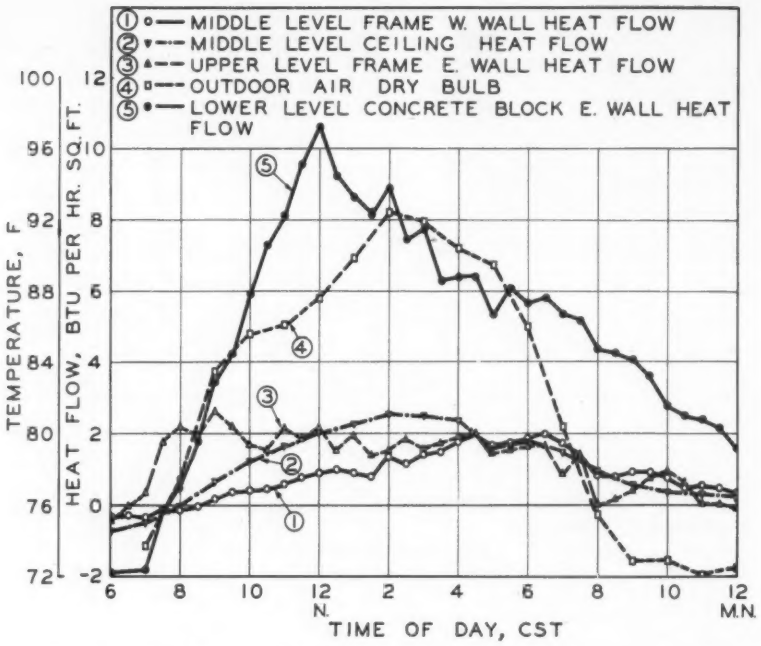


Fig. 5 Heat flow and temperature study in Residence No. 4, August 13, 1959

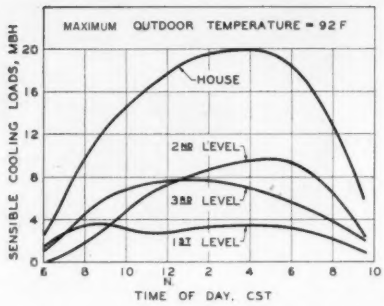


Fig. 6 Measured sensible cooling loads I-B-R Hydronic Research House, August 13, 1959

taneously, which is true for any house. Heat flow rates are affected by construction and orientation with the result that the maximum cooling load does not occur at the same time of day in all rooms or on all levels of a house.

Fig. 6 indicates that for a period of about 8 hr. the measured load was equal to or greater than 80% of the maximum. Thus, if a system were designed to satisfy a maximum load equal to the average calculated load for the highest 8-hr period of the design day, it would insure more or less continuous operation of the cooling system and at the same time the system would have capacity enough that there would be little if any overrun of house temperature.

Having decided that the factors through walls should be based on average heat flow rates over an 8-hr period, the problem of selecting the 8-hr period of the day to be used and the method of averaging still remained. Referring to Table 10, page 192, 1960 ASHRAE GUIDE, it will be noted that the period of maximum equivalent temperature difference (maximum heat transfer) is dependent on the mass of the wall. If maximum factors are desired it is apparent that different 8-hr periods will have to be used for the different wall constructions.

However, for design purposes, one is not interested in the maximum heat transfer rate through each wall or ceiling construction, but rather in the average heat transfer rate through each construction at the time of maximum load on the house.

Observations in both I-B-R Research Houses and in 3 Warm Air Residences have indicated that the maximum load on the house occurred before 6:00 PM Standard time, and the highest 8-hr period occurred between 10:00 AM and 8:00 PM regardless of the wall construction or amount of insulation used.

On the assumption that in a typical residence the peak load will always occur before 7:00 PM, the 8-hr period starting at 11:00 AM and ending at 7:00 PM was used to determine the average heat transmission factors to be used for wall constructions. The sensible heat gain through a wall is defined by the equation

$$H = A \times U \times ETD$$

where

H = Sensible heat gain through wall in Btu/hr

A = Wall area in sq ft

ETD = Equivalent temperature difference, a value used in place of outdoor-indoor temperature difference when estimating heat gains through walls. Equivalent temperature difference is adjusted to compensate for solar radiation effects. Generally accepted values of equivalent temperature differences are given in Table 10, page 192, 1960 ASHRAE GUIDE.

U = The coefficient of heat transfer in Btu/hr/sq ft/F.

Having determined previously that the wall constructions listed in Table I would be adequate for residential heat load calculations, the average equivalent temperature difference to use for each was determined in the following manner.

Frame and veneer walls: Using Table 10, page 192, 1960 ASHRAE GUIDE, all tabulated values of equivalent temperature differences for dark walls in the sections headed "frame" and "4-in. brick or stone veneer and frame" between 11:00 AM and 7:00 PM and without regard to orientation were averaged together, and corrected as directed in footnotes to the table to outdoor-indoor temperature differences of 15, 20, and 25 F (outdoor temperatures of 90, 95, and 100 F and an indoor temperature of 75 F). Dark wall equivalent temperature differences were used since the designer does not always know the wall color and dark wall values result in safe heat gain factors.

Masonry walls, 8-in. block or brick: The same procedure as described above was followed except that the tabulated values were taken from the sections of Table 10 headed "8-in. hollow tile or 8-in. cinder block," "8-in. brick or 12-in. hollow tile or 12-in. cinder block," and "8-in. concrete or stone or 6-in. or 8-in. concrete block."

Partitions: Again the same procedure was used but since partitions are always shaded, they were treated as north-facing walls.

Equivalent temperature differences as computed by the above methods are given in Table I. The heat gain factor is the product of the coefficient of heat transfer for each wall and the appropriate equivalent temperature difference. Table I shows the equivalent temperature differences determined by the above procedure, the assumed coefficient of heat transfer, and the resulting heat gain factor for each wall construction considered.

Ceilings: Measured instantaneous heat transmission rates for the ceilings of four residences located in Urbana, Ill., were obtained for all hours of the day over a range of summer conditions. Using the measured ceiling heat transmission rates for the same 8-hr averaging period as was used for walls, and determining sol-air temperatures by use of the method of analysis described on page 131 of the 1960 ASHRAE GUIDE, resulted in average sol-air temperatures of 114, 119 and 124 F at outdoor temperatures of 90, 95, and 100 F, respectively.

The sensible heat gain through ceilings is given by the equation:

$$H = U_o A (t_s - t_i)$$

where

H = Sensible heat gain through the ceiling, Btu/hr

U_o = The combination ceiling-roof heat transmission coefficient, Btu/hr/sq ft/F

A = Ceiling area, sq ft

t_s = Sol-air temperature, F

t_i = Indoor temperature, F

The 1960 ASHRAE GUIDE on page 131 presents a method whereby the combined ceiling-attic coefficient U_o can be determined from the ceiling U_c value. For example, a ceiling U_c value of 0.13 Btu/hr/sq ft/F combined with an attic ventilated at the rate of 0.1 air changes per hr (Natural Ventilation) results in a combined coefficient, $U_o = 0.10$.

In the equation for ceiling sensible heat gain, the U_o and temperature difference terms may be combined to result in the equation:

$$H = K A$$

where $K = U_o (t_s - t_i)$

If $U_o = 0.10$ and $t_s - t_i = 39$, the factor $K = 3.9$ Btu/hr/sq ft. All factors for ceilings in Table I were determined in this manner.

Infiltration: At best the assumed design infiltration rates are approximations. It is reasonable and convenient to relate infiltration to gross wall area. Direct measurement of the infiltration rate in two

TABLE I

PROPOSED HEAT GAIN FACTORS

Btu/hr/sq ft

Maximum Outdoor Temperature, F	FACTOR 90	FACTOR 95	FACTOR 100	ETD 90	ETD 95	ETD 100	U	
A. Walls and Doors								
1. Frame and Veneer on Frame								
a) No insulation	4.8	6.1	7.4	18.6	23.6	28.6	.26	
b) Less than 1 in. insulation, or one reflective air space	3.5	4.5	5.4	18.6	23.6	28.6	.19	
c) 1 in. to 2 in. insulation, or two reflective air spaces	2.4	3.1	3.7	18.6	23.6	28.6	.13	
d) More than 2 in. insulation, or three reflective air spaces	1.5	1.9	2.3	18.6	23.6	28.6	.08	
2. Masonry, 8 in. Block or Brick								
a) Plastered or plain	5.4	7.8	10.2	11.3	16.3	21.3	.48	
b) Furred, no insulation	3.4	4.9	6.4	11.3	16.3	21.3	.30	
c) Furred, with less than 1 in. insulation, or one reflective air space	2.3	3.3	4.3	11.3	16.3	21.3	.20	
d) Furred, with 1 in. to 2 in. insulation, or two reflective air spaces	1.5	2.3	3.0	11.3	16.3	21.3	.14	
e) Furred, with more than 2 in. insulation, or three reflective air spaces	1.0	1.5	1.9	11.3	16.3	21.3	.09	
3. Partitions								
a) Frame, finished one side only, no insulation	6.0	9.0	12.0	10.0	15.0	20.0	.60	
b) Frame, finished both sides, no insulation	3.4	5.1	6.8	10.0	15.0	20.0	.34	
c) Frame, finished both sides, more than 1 in. insulation or two reflective air spaces	1.4	2.1	2.8	10.0	15.0	20.0	.14	
d) Masonry, plastered one side, no insulation	1.2	3.0	4.7	3.5	8.5	13.5	.35	
4. Wood Doors*	9.3	11.8	14.3	18.6	23.6	28.6	.50	
B. Ceilings and Roofs								
1. Ceilings under naturally vented attic or vented flat roof							U_o**	U_c***
a) Uninsulated	9.0	10.2	11.3	39.0	44.0	49.0	.23	.44
b) Less than 2 in. insulation or one reflective air space	3.9	4.4	4.9	39.0	44.0	49.0	.10	.13
c) 2 in. to 4 in. insulation or two reflective air spaces	2.3	2.6	2.9	39.0	44.0	49.0	.06	.075
d) More than 4 in. insulation or three or more reflective air spaces	1.6	1.8	2.0	39.0	44.0	49.0	.04	.045
2. Built-up roof, no ceiling							U	
a) Uninsulated	15.6	17.6	19.6	39.0	44.0	49.0	.40	
b) 2 in. insulation	7.8	8.8	9.8	39.0	44.0	49.0	.20	
c) 3 in. insulation	5.5	6.2	6.9	39.0	44.0	49.0	.14	
3. Ceilings under unconditioned rooms	1.9	2.9	3.8	10.0	15.0	20.0	.19	
C. Floors								
1. Over unconditioned room	2.4	3.6	4.8	10.0	15.0	20.0	.24	
2. Over basement, enclosed crawl space, or slab on ground	0	0	0	0	0	0	0	
3. Over open crawl space	3.4	5.1	6.8	10.0	15.0	20.0	.34	
D. Infiltration, Btu/hr/sq ft gross exposed wall	0.97	1.30	1.62	½ air change				

* Treat Glass Doors Same as Windows

** Thermal conductivity of roof-ceiling combination, from GUIDE. (Multiply by ETD to obtain heat gain factor.)

*** Thermal conductivity of ceiling only, calculated.

experimental houses[6] indicated an infiltration rate, under summer conditions, of 0.5 air changes per hr, or 3.6 cfh/sq ft of gross wall area. The sensible heat gain due to infiltration is represented by the equation:

$$H_s = V \times d \times C_p \times (t_o - t_i) \times A$$

where

H_s = Sensible heat gain due to infiltration, Btu/hr
V = Infiltration, cfh/sq ft of gross wall area
d = Density of air, lb/cu ft
C_p = Specific heat of air, Btu/lb/F
t_o = Outdoor air dry bulb temperature, F
t_i = Indoor air dry bulb temperature, F
A = Gross wall area, sq ft

This may be simplified to $H_s = K \times A$ where K is all terms on the right side of the equation except A. If t_i is 75 F, K becomes 0.97 when $t_o = 90$, 1.30 when $t_o = 95$, and 1.62 when $t_o = 100$ F. These are the factors appearing in Table I under infiltration.

Glass: Having selected the period from 11:00 AM to 7:00 PM as the averaging period to establish heat gain factors for walls and ceilings, it would seem logical that the same period of time should be used for the glass. Factors were established from the ASHRAE data for glass for this period and the calculated sensible heat gains determined for the research houses for a day having a maximum outdoor temperature of 90 F. Comparing these calculated heat gains with those determined by test indicated that this procedure resulted in calculated heat gains which were too high, especially in rooms with western exposures. This suggested a longer averaging period which would include more of the morning hours and thus distribute the total glass load more evenly in all directions.

Using an averaging period from 5:30 AM to 6:30 PM and omitting data for 50 deg north latitude, as this latitude is north of most areas where cooling is required, resulted in calculated loads which agreed well with test results.

The instantaneous sensible heat gain through glass is expressed by the equation:

$$H = H_t + H_{rc}$$

where

H = Total instantaneous solar heat gain, Btu/hr/sq ft
H_t = Transmitted solar heat gain, Btu/hr/sq ft
H_{rc} = Solar heat gain by radiation and convection, Btu/hr/sq ft

Values of H_t and H_{rc} are given in Tables 12 and 13, page 196 of the 1960 ASHRAE GUIDE. The values were averaged for the 13-hr period from 5:30 AM to 6:30 PM. Values of H_t are not affected by indoor temperature. H_{rc}, however, is dependent on indoor temperature and the required corrections were applied to the H_{rc} averages. For a north window with an outdoor temperature of 90 F and an indoor temperature of 75 F, the average values are: $H_t = 18$, $H_{rc} = 8$, and $H = 18 + 8 = 26$ Btu/hr/sq ft. Table II lists factors for unshaded and shaded single and double glass which were determined by this method.

Table III is a comparison of the calculated and measured sensible cooling loads of the 5 houses. The cooling loads for all houses were calculated by Manual 11,[7] by Guide C-30,[8] and by the method proposed in this article. In addition, the loads for W. A. Residence No. 4 and the I-B-R Hydronic Research House were calculated by the ARI Standard 230[9] method. The indoor and outdoor temperatures used in determining all loads are noted on the table.

In W. A. Residence No. 4, the calculated loads are compared with the maximum measured load which occurred between 5:00 and 6:00 PM on August 13, 1959. The maximum outdoor dry bulb temperature on that day was 92 F. The calculation procedures are compared level-by-level and, additionally, the heat gains due to each component of the complete sensible load are compared.

By the Manual 11 method, the calculated load was equal to 92% of the measured load. However, the load estimation was based on an 80 F indoor temperature rather than the actual indoor temperature which was nearer 75 F. An estimation based on Manual 11 and a 75 F indoor temperature would result in a load in excess of the measured load.

The ARI method resulted in a calculated load equal to 108% of the measured load. This method is

TABLE II

GLASS FACTORS Btu/hr/sq ft

(30 and 40 deg N. Latitude)

	Maximum outdoor temperature, F					
	90	95	100	90	95	100
	Factors					
	SINGLE GLASS			DOUBLE GLASS[a]		
No inside shades						
N. (or shaded)[b]	26	31	36	19	21	24
N.E. and N.W.	58	63	68	43	45	48
E. and W.	84	89	94	61	64	66
S.E. and S.W.	73	78	83	72	75	77
S.	43	48	53	34	37	39
Shades half drawn (0.81)[c]						
N. (or shaded)	23	27	31	16	18	20
N.E. and N.W.	49	53	57	36	37	40
E. and W.	70	74	78	50	53	54
S.E. and S.W.	61	65	69	59	62	63
S.	37	41	45	29	31	33
Inside venetian blinds or drapes (.65)[c]						
N. (or shaded)	20	23	26	14	16	18
N.E. and N.W.	41	44	47	30	31	34
E. and W.	58	61	64	42	44	45
S.E. and S.W.	50	54	57	49	51	52
S.	31	34	37	24	26	27
Awnings or outside shade screens (0.35)[c]						
N. (or shaded)	14	16	18	10	10	11
N.E. and N.W.	26	28	30	18	19	20
E. and W.	35	37	39	24	25	26
S.E. and S.W.	32	33	35	28	29	30
S.	20	23	25	15	16	17

[a] [0.66 (Table 12)] plus [0.6 (Table 13)] plus [0.55 (Table 15)] Table numbers refer to those appearing in Chapter 13 of the 1960 ASHRAE GUIDE.
[b] Permanent shading such as roof overhang, adjacent buildings, etc.
[c] Multiplying factors selected from Table 25, Chap. 13, 1960 ASHRAE GUIDE for Medium Color Shading Devices.

TABLE III

COMPARISON OF CALCULATED AND MEASURED SENSIBLE COOLING LOADS

(Indoor Air Temperature of 80 F Used with Manual 11 and ARI-230, 75 F Used in all other cases)

House	Method of Obtaining Load	1st level	2nd level	3rd level	House	Glass	Walls	Ceilings	Flr.	Infil.
W. A. Residence No.2	Manual 11	12,747			12,747	5,311	1,790	4,040	00	1,606
(Outdoor Temp. 95 F)	Guide C-30	11,930			11,930	5,105	676	2,020	00	4,129
	Proposed	14,885			14,885	8,901	1,869	2,625	00	1,490
	Measured Max.				15,080					
W. A. Residence No. 3	Manual 11	14,751			14,751	5,306	4,340	3,072	00	2,033
(Outdoor Temp. 95 F)	Guide C-30	10,472			10,472	3,136	2,655	1,536	00	3,100
	Proposed	12,387			12,387	4,208	4,935	1,994	00	1,160
	Measured Max.				11,890					
W. A. Residence No. 4	ARI-230-57				25,059	8,801	6,158	5,652	438	4,010
(Outdoor Temp. 90 F)	Manual 11	4,453	8,039	9,024	21,516	8,500	3,675	2,843	341	6,157
	Guide C-30	10,000	5,313	7,819	23,132	6,389	3,481	3,041	119	10,102
	Proposed	6,159	7,722	9,389	23,270	11,657	6,284	3,249	170	1,910
	Measured Max.	4,220	10,900	8,160	23,240					
I-B-R Research Home	Manual 11	8,705	8,615		17,320	7,810	3,105	2,800	00	3,605
(Outdoor Temp. 100 F)	Guide C-30	6,850	7,475		14,325	7,150	1,755	1,600	00	3,800
	Proposed	7,950	8,880		16,830	8,950	3,600	1,840	00	2,440
	Measured Max.	5,098	5,979		11,077					
I-B-R Hydronic Research	ARI-230-57				41,845	25,140	5,875	5,150	3,225	2,455
House	Manual 11	5,710	18,425	8,325	32,460	22,420	3,630	2,885	2,075	1,450
(Outdoor Temp. 90 F)	Guide C-30	4,725	9,600	5,650	19,975	10,825	2,875	2,200	1,025	3,050
	Proposed	4,120	7,120	6,600	17,840	9,710	3,920	2,710	00	1,500
	Measured Max.	3,350	9,350	7,150	19,850					

also based on an 80 F indoor temperature and with 75 F would result in a much greater estimated load.

The load estimated by the Guide C-30 method was nearly equal to the measured load. This was due to the fact that the infiltration factors for the lower level concrete block walls were unusually high. This is shown by the comparison of the infiltration components as determined by the three methods and also by comparison of the lower level loads. Without the high infiltration allowance, the Guide C-30 method would result in a calculated load less than that determined by the other procedures and also less than the measured load.

The load estimated by the proposed method was equal to 101% of the measured load. The proposed method is based on a 75 F indoor temperature and distributes the direct solar heat gains among all of the rooms.

The W. A. Residence No. 2 loads as calculated by both Manual 11 and Guide C-30 were less than the measured load while the proposed method resulted in a load equal to 99% of the maximum measured load. Again, if the Manual 11 method had been applied with a 75 F indoor temperature, the resulting load would have been higher. The Guide C-30 method, without the high infiltration allowance, would have resulted in a calculated load of only 62% of the measured maximum.

In the case of W. A. Residence No. 3: the Manual 11, Guide C-30, and proposed methods resulted in loads 124, 88 and 104% of the measured load, respectively. The proposed method resulted in a better approximation of the actual load than any of the other methods.

For the I-B-R Hydronic Research House, the use of either Warm Air Manual 11 or ARI Standard 230 resulted in calculated sensible heat gains well in excess of the measured maximum value. Examination of Table III indicates that most of the excess was in the gains attributed to glass. Better than 50% of the glass area in the Research House faced the northwest and both manuals used high radiation factors for this orientation.

The calculated sensible heat gain for the Research House obtained by use of the proposed factors was about 10% less than the measured sensible heat gain. In this specific instance, the calculated heat gain obtained by the use of Guide C-30 was in best agreement with the measured value. The floor gains and the infiltration gains as computed by Guide C-30 were both high and if these were reduced to correspond with normal gains to be expected from these sources, the calculated load as obtained by Guide C-30 would be in close agreement with that obtained by the use of the proposed factors.

The calculated heat gain for the first level, obtained by the use of the proposed factors, was high as compared to the measured heat gain. This same condition was observed in W. A. Residence No. 3 and on the first level of W. A. Residence No. 4. In each instance the floor consisted of a concrete slab on the ground and it is assumed there was a negative heat gain (heat loss) through the concrete floors. In all methods of calculating the heat gains, the heat loss through a concrete floor on the ground is assumed to be zero.

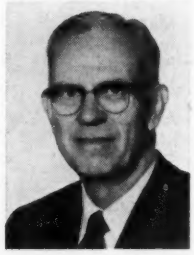
Measured floor surface temperatures in the den and recreation room of the I-B-R Research House were from 0.5 to 1.7 F lower than the air temperature 3 in. above the floor. Using the average difference of 1.1 F and a film coefficient of 1.08 it would appear that the heat flow from the rooms to the ground was approximately 1.2 Btu/hr/sq ft of floor area or about 590 Btu/hr for the entire first level. Subtracting 590 Btu/hr from the calculated

(*Continued on page* 108)

It is possible to create artificial gravity and use

Refrigerating equipment

for the cooling of space cabins



R. S. TAYLOR
Member ASHRAE

In controlling the climate of confined spaces, heating and cooling are involved as well as the chemical composition of the enclosed atmosphere. How much and what type of control is required depends on the purpose for which the enclosed atmosphere is to be used. For example, if rusting of iron or steel is to be inhibited, only humidity needs be maintained at a suitable level. Many other moisture sensitive products require humidity controlled atmospheres in storage or when shipped from a low temperature area to or through a warmer and more moist area. In instances where the atmosphere is controlled for human or animal occupancy, other characteristics such as temperature, carbon dioxide content, trace impurities content, etc., must also be kept under control.

When a fixed volume enclosed space is used for a "Human Occupancy Cabin," humidity is not of major importance if the ambient temperature is low enough that heat must be supplied for comfort. The only method of self cooling given to the human body is evaporation of moisture from its surface. At temperatures where convective or forced draft cooling alone cannot remove body heat to maintain normal body temperatures, cooling and/or humidity removal is a necessity.

For enclosed spaces as commonly encountered numerous types of cooling and dehumidifying devices are available. With the advent of space exploration, another parameter has been added: the absence of gravity. Since practically all mechanical devices depend on gravity in some way for their successful operation, the purpose here was to determine the possibilities or alternates for cooling or rather "atmosphere conditioning" of enclosed spaces or cabins without the assistance of gravity.

Two ways of achieving these possibilities are:
1 – By creating an artificial gravity for or in a space cabin by using centrifugal force, conventional types of equipment, either power or heat operated, can be built for the purpose intended. The refrigerating equipment alone can be made the artificial gravity (by centrifugal force) "platform" or the entire space cabin can be rotated about an axis when it is beyond the influence of the earth's gravity to subject the total contents to an artificial gravity.

Every refrigeration system must have a "heat sink" to enable condensation of the refrigerant. If the axis of rotation is such that one end points toward the sun and the other towards space, then the radiation to space can be used as the "heat sink" balancing the absorption of heat from the sun and the radiation to outer space by means of relative insulation thickness on the two ends. A cylinder with its axis or rotation so oriented is preferable to a sphere since a larger area with constant centrifugal force is thus obtained.

2 – The other way is to choose some type of refrigeration device which will function in the absence of gravity. Since none of the existing refrigerating systems have been called upon to function under "gravity-less" conditions, the alternates and modifications needed to make them operable under these special conditions should be examined. Even if the space cabin is set up for artificial gravity creation, there may be times when it will be necessary to stop its rotation and work in a pressure suit for observations or repair work. Equipment operable under "gravity-less" conditions will then be required.

The earth and its atmosphere stay at an overall average temperature which supports life because of a balance between the radiant energy absorbed from the sun and the energy radiated from the earth to outer space. Any temporary unbalance represents a gradual warming or cooling of the earth until the balance is restored. The present gradual warming trend is caused by an increase of carbon dioxide in the earth's atmosphere which causes the earth to

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absorb and hold more heat. If a control of the energy absorbed and of the energy reradiated by a cabin in space could always be accomplished, refrigeration would not be necessary.

In the absence of gravity, liquid particles will not change position. Diffusion or circulation in gases or liquids due to differences in density caused by either temperature or concentration differences will not occur because this type of diffusion depends on gravity. A drop of liquid which contacts a second one coalesces because the force of impact (caused by gravity) overcomes the surface tension at the surface of the drops. In the absence of gravity, any droplets formed or existing as droplets remain so even on contact unless the force of contact is sufficient to overcome or counteract the surface tension.

Gases or vapor circulate due to pressure differences independent of gravity. Liquid condensed or absorbed on a surface remains there by surface tension or capillarity. Osmotic diffusion due to osmotic pressure differences occurs in liquids and solids. There is also some diffusion by kinetic means in gases and liquids. Hence, circulation in the no-gravity unit should be in the vapor or gaseous phase.

Condensed liquids must be held in the liquid phase in porous solids by capillarity or confined by means of membranes or microporous plastic permeable to vapor but not to liquid. In space there is zero atmospheric pressure or in effect no atmosphere so that any gaseous materials lost to space are permanently lost. Heat transfer must be by conduction and radiation except where pressure differences cause movement of gases or vapors.

. . . cooling enclosed rooms in space can be achieved when artificial gravity is produced . . .

. . . refrigerating equipment alone can be subjected to artificial gravity (by centrifugal force) . . .

. . . If a control of the energy absorbed and of the energy reradiated by the cabins in space could always be accomplished, refrigeration would not be necessary . . .

. . . the simplest method of cooling would be to evaporate stored refrigerant into ambient pressure . . .

. . . carbon dioxide driven off in continuous regeneration can be used in a concentrated form for reconversion to oxygen . . .

FORMS OF COOLING

The simplest form of cooling is to evaporate stored refrigerant into ambient pressure. Since there is zero ambient pressure in space any refrigerant could be used. Water has the highest latent heat per pound evaporated and is the most efficient refrigerant from the viewpoint of refrigeration produced per pound of refrigerant evaporated.

The liquid refrigerant must be held by capillarity in a porous solid material or by means of membranes permeable only to vapor to assure evaporation in the evaporator rather than lose liquid particles which would be carried by the escaping vapor and result in lost refrigerating effect.

There is another form of stored cooling which may have some uses. The cabin would probably be filled with oxygen at a pressure of five to seven psi Absolute if used for human occupancy. Carbon dioxide and moisture exhaled should be removed and the oxygen consumed be replaced. For short time occupancy the carbon dioxide is removed with suitable absorbents and the moisture by dryers or condensation. For longer term occupancy the carbon dioxide should be reconverted to oxygen and the moisture recovered for future use or reuse.

It may sometimes be necessary to remove trace contaminants generated. The make-up oxygen as needed should come from a physical source such as liquid oxygen or as compressed oxygen in cylinders, or from a chemical source such as hydrogen peroxide. If the make-up oxygen from cylinders is used to do work in an expansion engine, cooling will be obtained.

Work available from the expansion engine can be used for any desired purpose, such as to cause atmosphere circulation in the cabin. If there is no positive circulation in the enclosed space, the exhaled oxygen which (when gravity is present) removes itself due to density differences, will not move but will choke the occupant due to local build-up and rebreathing. When hydrogen peroxide is used as the source of oxygen, heat is generated by its decomposition rather than cooling.

Of the continuous mechanical type refrigerating units, the only one in principle independent of gravity is the "dense air" unit. This type unit can be designed for a space cabin using oxygen instead of air. At no place in the "dense air" unit is there any liquid refrigerant, only gaseous. Circulation of the "dense air" or oxygen is caused by pressure differences. Hence this type unit can be built to operate continuously in a gravity free environment if power is available and if a suitable "heat sink" is provided to enable cooling of the compressor and compressed gas.

Heat operated refrigeration units offer several possibilities. All known liquid absorption units depend on gravity. Solid absorbents provide a means of fixing the absorption chemicals. Vapors condensing in the condenser-evaporator should be held in place with semi-permeable or micro-porous plastics membranes or by capillary fillings.

This form of unit is in the category of intermittent units. Heat is applied to the absorber-generator and removed at the condenser during the regenerating cycle. During the refrigerating cycle, refrigeration is produced in the evaporator-condenser part of the system and heat is rejected from the absorber-generator part.

For continuous refrigeration two intermittent systems are needed. The absorbent-refrigerant combination chosen depends on the temperatures wanted produced from the system. If a liquid refrigerant and a liquid absorbent are chosen, they can be kept in their respective locations by means of capillarity using inert filling materials or by membranes permeable to vapor but not to liquid.

A cabin for human occupancy must contain

oxygen for breathing and since the human body exudes water for self cooling, this water and the oxygen can be a part of an inert gas system. For example, the oxygen can be circulated past a water absorbent (lithium chloride or bromide), held in a large surface capillary medium (for example, small flute corrugated asbestos paper). This will absorb the moisture evaporated from the human body so that more can evaporate and cool the body.

The water absorbent medium can be regenerated by heating to drive off the moisture which is used as replacement moisture for the human body. This system can be made intermittent or continuous. For the continuous system a rotating drum can be used with one segment of the drum serving continuously as the absorber while the other segment is constantly regenerated.

A similar device or system, but using other absorbents, can be built for continuously absorbing carbon dioxide from the oxygen. The carbon dioxide driven off in continuous regeneration can be discarded to space with consequent loss of carbon and oxygen, or it can be used in a concentrated form for reconversion to oxygen depending on the need.

No attempt has been made here to delineate the particular application for each system. This depends on the specific use and problem situation requiring solution. As with many problems there will usually be several solutions and the choice must be made after an analysis of the various possibilities.

Although the absence of gravity and external atmosphere causes changes in the problem, techniques of the past can be applied with modifications to control the climates of our future space cabins.

Advisers organize plans for notable 15th International Heating & Air Conditioning Exposition

Headed by ASHRAE President Walter A. Grant, as chairman, the advisory committee for the 15th International Heating & Air-Conditioning Exposition, to be held at the International Amphitheatre in Chicago, February 13-16, 1961, has a membership of 33. It includes members of the Board of Directors, presidents of local chapters of ASHRAE, and heads of associations representing major interests in the fields of heating, refrigeration, cooling, ventilation and air conditioning.

Nearly 500 exhibitors have already contracted for product and equipment displays.

Representing ASHRAE on the committee are: H. G. Gragg (chairman arrangements committee, ASHRAE meeting); W. S. Harris, Axel Marin, L. K. Warrick and V. D. Wissmiller (as members of the Board of Directors).

Presidents of ASHRAE chapters include: W. V. Richards, Illinois; R. F. Demange, Illinois-Iowa; John R. Bain, Iowa; Mark O. Wehmeyer, Michigan; W. M. Hassenplug, Central Michigan; S. R. Curtis, Western Michigan; Donald F. Swanson, Minnesota; and Fred W. Goldsmith, Wisconsin. All these chapters are within Region VI.

Representing affiliated professional and business interests are: W. C. Miessemer, President, Air-Conditioning & Refrigeration Wholesalers; E. F. Snyder, President, Air Filter Institute; Irving W. Clark, Exec. V. P., Air Moving and Conditioning Association, Inc.; Harry A. Belyea, President, Air Pollution Control Association; Wister H. Ligon, President, American Gas Association; Philip Will, Jr., F.A.I.A., President, American Institute of Architects; R. H. Tatlow III, President, American Institute of Consulting Engineers; F. W. Earnest, Jr., President, Anthracite Institute; Ennis C. Smith, President, Cooling Tower Institute; Sherman R. Knapp, President, Edison Electric Institute; R. E. Ferry, Gen. Mgr., Institute of Boiler and Radiator Manufacturers; Joseph S. Kearney, President, Mechanical Contractors Association of America, Inc.; John N. Mariakis, President, National Association Practical Refrigerating Engineers, Inc.; Stephen F. Dunn, President, National Coal Association; Albert F. Metzger, President, National District Heating Association; Harry C. Gurney, President, National Warm Air Heating and Air Conditioning Association; Fred Heaney, President, Oil-Heat Institute of America; R. A. Locke, Mgr., Steel Boiler Institute, Inc.; and W. B. Baer, President, Stoker Manufacturers Association. Local interests will also cooperate.

ASHRAE NATIONAL MEETINGS AHEAD	1961	1962	1963
	Feb. 13-16 Semiannual Chicago, Ill.	Jan. 28-Feb. 1 Semiannual St. Louis, Mo.	Feb. 11-14 Semiannual New York, N. Y.
	June 26-28 Annual Denver, Colo.	June 25-27 Annual Miami, Fla.	

Noise suppression

in oil burners

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H. F. SCHROEDER

Importance of noise to the purchaser of heating and air conditioning equipment has been amply demonstrated. ASHRAE has devoted considerable effort toward understanding and solving the problems associated with noise. Much of this effort has been directed at the problems of mechanical noise such as compressor and blower operation, duct noise, insulation, etc. In oil-fired furnaces and boilers, however, much of the noise originates in the oil burner itself.

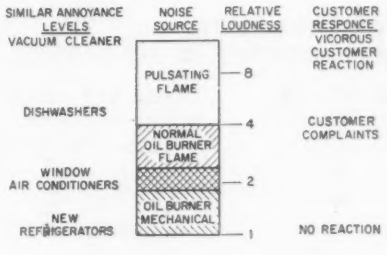
Burner noise is created by both the flame and the mechanical components of the burner. However, as shown in a previous paper,[1] the flame is the major source of oil burner noise. Hence, an experimental study of oil burner flame noise was carried out to determine the mechanisms by which the noise was produced. The objective was to develop an effective means of reducing noise level by simple adjustments to existing equipment.

Two types of flame noises were examined: high level throbbing noise or "pulsation," and low level normal noise or "combustion roar." The former type is not prevalent in most burners, but when it does exist, severe complaints are received from homeowners. The annoyance of oil burner noise can be compared with common household appliances.[2,3] For example, a pulsating oil burner is as annoying as a vacuum cleaner, a nonpulsing burner approximates a window air conditioner and the mechanical noise from a quiet oil burner is about the same as a new refrigerator.

A bar graph comparing these annoyance levels is shown in Fig. 1. This comparison assumes that the listener is standing next to the oil burner. However, if the burner is in the basement and the listener is in the living room, the burner sound level would be reduced at least 10 db.[4] This means that a pulsing flame in the basement would be as annoying as a dishwasher when listening to it in the living room. However, even these lower annoyance levels are still too high and should be reduced.

Noise Levels Measured With Conventional Equipment – A typical furnace-burner combination was chosen to examine both types of flame noise levels. Two conventional warm air furnaces with output ratings of 72,000 Btu/hr and 90,000 Btu/hr were used. They are representative of the smaller sized furnace which is gaining popularity in new homes today. The oil burners tested in these furnaces were also typical of those found in the field. A commercially available high pressure gun burner was used to study normal combustion noise. To study pulsation flame noise, a typical low pressure air atomizing burner was used.

Fig. 1 Relative loudness of oil burner noises



Standard sound instruments were used to determine the sound spectrums of the noise from the oil burners. Burner noise is composed of sound waves of all frequencies in the audible spectrum (20-20,000 cycles/sec). However, in most test work, it is not necessary to analyze the spectrum for sound pressure level as a continuous function of frequency; rather, the sound level is measured in "octave bands." These octave bands have the same frequency limits as octaves on the piano keyboard. The sound pressure level gradient obtained by this method gives a good approximation of the entire spectrum and was used in this analysis of burner noise.

Sound instruments used in this program gave results reproducible within 1 db. Under normal conditions the human ear can barely detect this one db change in sound pressure level. A commercially available sound level meter was used for detection, and sound measurements in the octave bands were made with a standard octave band frequency analyzer. These instruments were checked and calibrated daily. They were always located in the same position relative to the furnace and this location was chosen as the point at which the sound pressure level was most critical. The microphone orientation is shown in Fig. 2. A cathode-ray oscilloscope and oscillator were used to determine the pulsing frequencies.

All the sound measurements were made in a remotely located sound laboratory. The background noise of this laboratory was extremely low and equivalent to the noise level of a radio broadcasting

R. W. Sage ad H. F. Schroeder are with the Process Research Div, Esso Research and Engineering Company. This paper has been prepared for presentation at the ASHRAE Semi-annual Meeting, Chicago, Ill., February 13-16, 1961.

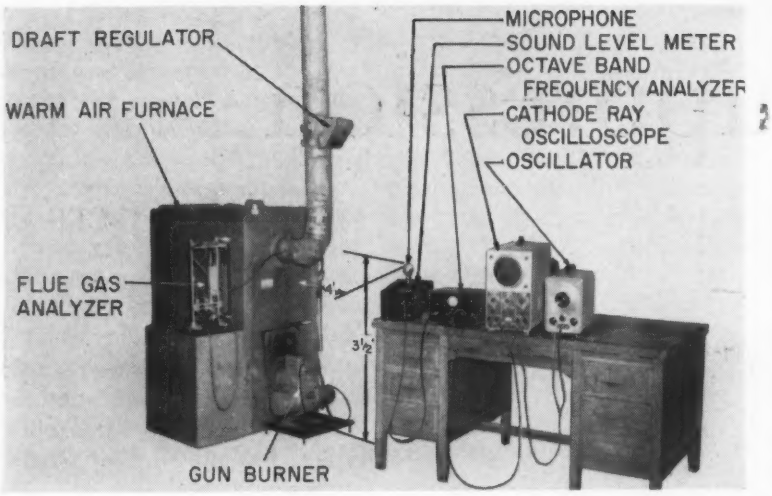


Fig. 2 Laboratory noise test equipment

studio. The sound pressure level gradient obtained was at least 30 db below the total burner noise in any given octave band. Since this background noise level was much less than the burner noise, it could not contribute to the total noise level.

PULSING FLAME NOISE

Pulsation Studied With Aid of High Speed Motion Pictures—The loudest and most annoying noise found in domestic oil burners is pulsation. This phenomenon does not occur in all oil burners. But when it does, it dominates all other noise and becomes a focal point for serious complaints. Therefore, the first phase of our noise study was concerned with pulsation and how it could be controlled. Our program consisted of determining:

1. How pulsations originate and are perpetuated.
2. What effect burner and furnace variables have.
3. What simple, practical device can be built to eliminate pulsation.

A pulsing oil burner flame in the warm air furnace was photographed at 3000 frames/sec. These pictures showed that the flame was flickering "on" and "off" in the combustion chamber. The flame was not anchored in the normal position near the burner blast tube, but periodically traversed the combustion chamber and disintegrated against the rear wall. At the same time a new flame front was forming which followed the same procedure. At all parts of the cycle, some flame always existed in the combustion chamber. This periodic flame extinction coincided with the predominant 30 cycle sound wave measured on the oscilloscope, indicating that a definite relationship existed between pulsation noise and flame extinction. A typical frame from the high speed movies is shown in Fig. 3.

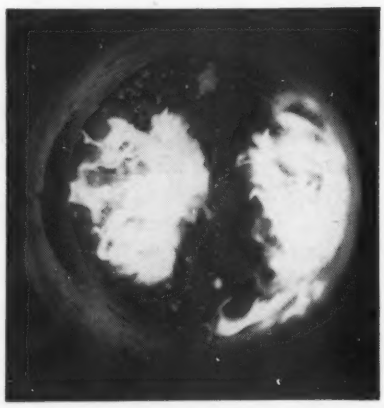


Fig. 3 Pulsing flame. Top view of combustion chamber. Air and oil enter on left

These high speed motion picture studies and supplementary tests enabled a pulsation mechanism to be postulated. The energy of the sound waves generated by the combustion process can be expressed by the classical formula:

$$I = \frac{P^2}{dC}$$

where:

I = sound intensity or energy per unit time flowing through a unit area

P = root mean square value of instantaneous pressure over the given time interval

d = density of combustion gases

C = velocity of sound in combustion gases

It was postulated that pulsation occurs when the energy level of the sound waves in the furnace is sufficient to significantly retard the flow of combustion air through the burner blast tube. The magnitude of this energy is dependent largely on the pressure level or amplitude of the waves as shown by the above equation.

When resonant conditions exist between the flame and furnace, high amplitude sound waves of this resonant frequency build up to the energy level required to retard the flow of combustion air. A rich fuel-air mixture therefore is momentarily produced which cannot support combustion, at which time the flame "goes out." This produces a low pressure zone and results in a surge of air into the combustion chamber. Re-ignition occurs and the flame is re-established to complete the cycle. This periodic flame extinction and re-ignition occurs about 30 times per sec and can be observed easily by high speed motion pictures. To the naked eye, however, the flame appears to fill the chamber com-

TABLE I

VENTING HOLES MOST EFFECTIVE IN COMBUSTION CHAMBER

Vent Hole Location	Vent Area, In.² Required for No Pulse
Combustion Chamber	0.98
Heat Exchanger	3.14

TABLE II

PRESSURE RELIEF, NOT EXCESS AIR ELIMINATES PULSATION

Air Delivered Thru Manifold, SCFM	% Excess Air Required to Eliminate Pulsation	
	Vent Open	Vent Closed
0	39	65
1	37	69
2	43	73
3	46	80

TABLE III

OPTIMUM VENTING AREA DEPENDS ON FURNACE AND FIRING RATE

Furnace	Firing Rate, Gallon/Hr.	Optimum Vent Area, In.²
72,000 Btu/Hr	0.5	0.9
72,000 Btu/Hr	1.0	1.2
90,000 Btu/Hr	0.5	0.6
90,000 Btu/Hr	1.0	1.8

pletely at all times. This mechanism appears to be in agreement with the findings of Sanders and Lawrie[5] and Putnam and Dennis.[6]

This mechanism opened two avenues of approach to the problem:

(A) Make the flame less sensitive to changes in air delivery.

(B) Dampen the acoustic system and thereby minimize changes in air delivery.

Flame Stabilization Prevents Pressure Buildup—The first method of eliminating pulsation suggested by the mechanism was to make the flame less sensitive to changes in air delivery. One way of doing this is to eliminate the driving force, that is, to stabilize the flame with a flame holder. This device is an obstruction placed in the combustion air stream which sets up a stagnation zone, acts as a pilot, and thus prevents the flame from "blowing" downstream. With the flame thus anchored, the changes in air delivery caused by pressure surges do not have such a drastic effect on the flame and acoustical energy does not build up in the system. Pulsations are therefore eliminated.

Unfortunately, this solution is not practical in intermittently operated oil flames because of coke buildup when the unvaporized oil droplets strike the cool metal flame holder. Home oil burners operate intermittently, and such deposits would create servicing problems. On the other hand, this solution seems practical in commercial boilers which operate continuously because the coke would be removed as fast as it forms.

Venting Relieves Pressure Buildup and Stops Pulsation—The second method of eliminating pulsation suggested by the mechanism was to dampen the acoustical system and thereby minimize changes in the flow of incoming combustion air. This can be done most effectively by venting the combustion zone to the atmosphere.

Venting was provided on the laboratory furnace by providing twelve ½-in. diam holes into the combustion chamber. To accomplish this, a "venting plate" shown in Fig. 4a was attached to the burner blast tube. The location of

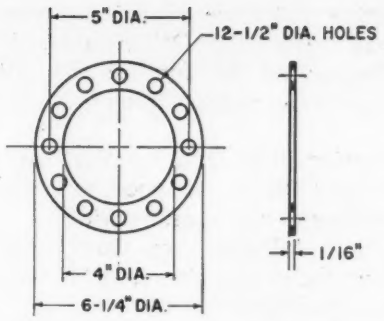
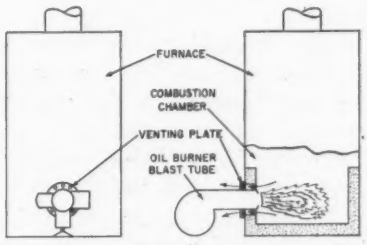


Fig. 4a Sketch of anti-pulsing venting plate

Fig. 4b Anti-pulsing venting plate installed



NOTE: BURNER BLAST TUBE NOT SEALED INTO COMBUSTION CHAMBER. ANNULAR OPENING AROUND END CONE MUST AT LEAST EQUAL VENTING AREA.

the venting plate in relation to the furnace is shown in Fig. 4b. With this plate installed, pulsation was eliminated and noise level was reduced substantially. These results are shown graphically in Fig. 5 where the db measured in each octave band are plotted for both a pulsing and a nonpulsing flame. With pulsation eliminated the entire sound pressure level gradient is reduced, but even more significant is the absence of the most annoying component in the 20-75 cps octave band. This component is reduced from 92 to 76 db which cuts the relative loudness in half.

When the venting area was moved to locations further from the combustion zone, the ability to reduce fluctuations in incoming combustion air was less. This was determined by the area required to relieve pulsation at two locations in the furnace. When vented at the combustion chamber only one sq in. of area was necessary to relieve the pulse. However, when vented in the heat exchanger, three sq in. of area was required. Large areas, of course, lower efficiency by admitting excess air. These data are shown in Table I and demonstrate the effectiveness of locating the vent holes at the combustion chamber.

When the combustion chamber is vented, excess combustion air is admitted through the venting holes. The question then arose as to whether the pulsations were eliminated by pressure relief or by the addition of excess air. Addition of excess air through the burner blast tube is known to eliminate pulsation, because of the increased pressure drop available to retard the advance of the oncoming pulsation or standing wave. Therefore, if the mechanism is pressure relief, less excess air should be required to eliminate pulsations.

TABLE IV

OTHER TECHNIQUES WORK BUT SEEM IMPRACTICAL

Technique	Range Tested	Remarks
1. Decreased Tendency to Pulsate By:		
Increasing Draft	0.015 to 0.130 in. H_2O	Inefficient burner operation and required draft too high.
Increasing Excess Air	0 to 70%	Inefficient combustion at 70%.
Changing Atomizing Air*	4 to 8 in. Hg Pressure	Noisy or inefficient combustion.
Increasing Oil Pressure	60 to 140 psi	Impractical increases required.
Lowering Firing Rate	0.90 to 0.50 gph	Required rate too low for practical use.
Acoustical Damping	Various dashpots and surge chambers	Size of devices impractical in field.
Increasing Air Pressure Drop Through Burner	0.04 to 0.50 in. H_2O	Required pressure drop too high for conventional fans.
2. Pulsation Not Affected By:		
Changing Oil Distribution Pattern of High Pressure Nozzle	Symmetrical to lopsided	No effect.
Recirculating Combustion Products	Baffles installed to shorten or lengthen residence time	No effect.
Eliminating any Possible Fluctuations in Oil Feed*	Fed oil to burner by gravity	No effect.

* Low pressure, air atomizing burner only

Experiments showed that when air was supplied through a manifold to these vent holes, the total amount of air required to eliminate pulsation was increased. However, when the vent holes were opened to the atmosphere, the total amount of air required to eliminate pulsation was decreased. These data show clearly that the effect of the vent holes was primarily an acoustic one. These test data are assembled in Table II.

Another possibility is that the venting holes altered the resonant frequency of the system and prevented pulsation. However, laboratory tests showed that these holes did not change the pulsing frequency.

It was concluded from these data that venting stops pulsation by pressure relief and not by excess air addition or changes in resonant frequency of the system. This conclusion was confirmed by later experiments, where different diameter holes and thickness of pressure relief plates were used to achieve the same venting area. The plates with the smallest pressure drop through the venting holes eliminated pulsation with the least amount of excess air, indicating that more acoustic pressure was relieved. Other acoustic changes to the furnace did not change the pulsing frequency.

Venting Plate Is A Practical Anti-Pulsing Device – A good, practical venting device must provide:

1. Adequate pressure relief from the combustion zone to eliminate pulsation.
2. Minimum losses in efficiency.
3. Ease of installation and adjustment.
4. Low initial cost.
5. Adaptability to most heating units.

The simplest device found in our laboratory studies that meets these requirements is the venting plate.

Twelve ½ in. holes are available for pressure relief, if necessary. Different units and firing rates have different venting area requirements, as shown by the data listed in Table III. These laboratory tests on two warm air furnaces indicated, however, that twelve ½ in. holes are ample for small, pulsation-prone, domestic furnaces. The laboratory units had capacities of 72,000 and 90,000 Btu/hr and were fired over a range of 0.5 to 1.0 gph. In no case were more than nine holes needed to eliminate pulsations. In larger units using higher firing rates more energy release is involved and hence venting area requirements could be greater. However, larger units are less prone to pulsate and further tests are needed to substantiate the extrapolation above one gal/hr.

Loss In Efficiency Is Negligible – Although venting holes prevent pulsation by relieving acoustic pressure, they can admit a small quantity of air to the combustion zone and thereby reduce efficiency. The second requirement of a practical venting device must be to minimize these losses in efficiency.

Laboratory tests were therefore made to determine the maximum efficiency of a test unit using the venting technique. A series of runs were made at various venting areas ranging from 0 to 2.0 in.^{2} At each venting area, the primary air shutter was gradually closed until either pulsation or smoke occurred. The excess air was measured at this first incipient point.

At low venting areas, pulsation limited the maximum obtainable efficiency. As the venting area was increased, the pulsing tendency was decreased, which allowed the burner to operate with less excess air and efficiency increased. These data are shown in Fig. 6a. When the venting area was increased still further, too much air was admitted through the vent holes which caused inefficient air-oil mixing and inefficient combustion. Hence, at large venting areas satisfactory operation of the burner was limited by smoke formation rather than pulsation.

These data also plot as a smooth curve and are shown in Fig. 6b together with the previous pulsation limiting curve. The intersection of these two curves represents the optimum venting area since it is the maximum efficiency attainable without either smoke or pulsation occurring. It is less than 1% lower than the efficiency obtained with the same burner in a pulsation-free furnace. This small loss in efficiency should not be serious, and from these data it was concluded that the venting plate

TABLE V

FACTORIAL-TYPE EXPERIMENT FOR NONPULSING COMBUSTION NOISE

Numbers shown are the average overall sound pressure levels, in decibels, for several runs.

Combustion Chamber, 9 I.D. x 12 in. High, Hard Pre-Fab Material
Draft, In. H_2O Measured Over Fire

Firing Rate, gph	% Excess Air	0.015 Flame Shape 30 F	0.015 Flame Shape 80 F		0.050 Flame Shape 30 F	0.050 Flame Shape 80 F	
1.00	125	73.8	78.2 69.2[2]	69.8[2]	74.3	76.1	69.0[2]
	40	76.0	79.1		71.9	75.8	
0.75	125	75.5	75.8 73.3[4]	76.5[1]	71.8	72.8	73.8[4]
	40	73.6	77.0	76.7[4]	72.7	76.8 76.5[3]	75.5[1] 77.6[4]
0.50	125	73.5	72.0		71.0	70.3	
	40	X	73.8		X		X

(1) Hollow cone nozzle.
(2) Position of inner air sleeve changed.
(3) 7 in. diam stainless steel combustion chamber.
(4) 8 x 8 x 12 in. high, soft 2000 F firebrick combustion chamber.

meets the second requirement of minimizing efficiency losses.

The other design requirements, ease of installation, low cost and adaptability to most heating units, are satisfied by the simplicity of the thin plate. This low cost device is installed merely by sliding it onto the blast tube and sealing it to the front of the furnace. The only time an installation would be more involved would be when the burner is sealed to the inside of the combustion chamber. In such cases, an opening would have to be provided in the combustion chamber around the blast tube equal or greater in cross-sectional area to that required for optimum venting. A diagram of a typical installation is shown in Fig. 4b.

Other Techniques Can Work But No Practical Ones Were Found—Many attempts were made to eliminate pulsation by simple burner and furnace changes. The techniques used, the range tested and the results are tabulated in Table IV. Although most of the changes were capable of decreasing the tendency to pulsate, none eliminated it entirely without reducing combustion efficiency substantially.

Those changes that did not decrease efficiency seemed impractical for existing burner installations. For example, the tendency to pulsate was decreased by increasing the air pressure drop across the burner end cone. Unfortunately, conventional burner fans do not build up high enough static pressures to entirely eliminate pulsations. In our tests, the maximum obtainable pressure drop of 0.25 in. H_2O was insufficient. Even when 0.50 in. H_2O was developed with the aid of a supplementary blower, pulsation occurred. Sanders and Lawrie[4] recommend a fan capable of developing 2 to 3 in. H_2O to insure pulsation-free operation for oil burner operation.

Because no sure-fire remedy was found for pulsations by simple burner and furnace adjustments, these results were considered to be further proof that the venting plate is the best practical anti-pulsing device.

Easily Controlled Flame "Variables" Studied—The second phase

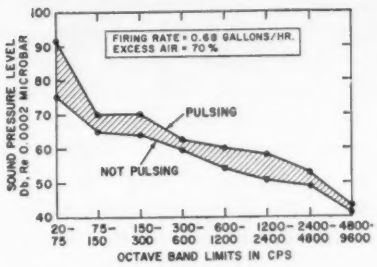


Fig. 5 Elimination of pulsation reduces burner noise level

of the burner noise study was concerned with non-pulsing flame noise or "combustion roar". As shown previously, the flame itself is the major contributor to high noise levels. The problem of determining how to reduce this noise was approached by detailed consideration of the operating variables subject to change, that would alter flame characteristics. The variables considered were:

Firing rate
Flame pattern
Excess air
Draft
Combustion chamber design
Nozzle design
Fuel characteristics

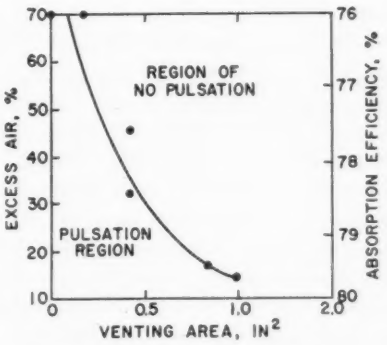
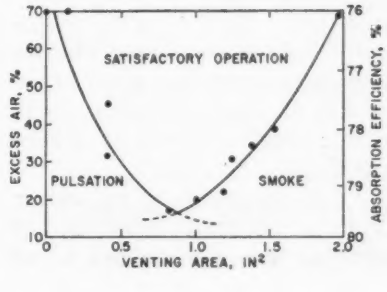


Fig. 6a Increasing venting area lowers excess air required to stop pulsation

Fig. 6b Too much venting area causes inefficient use of air



The fuel characteristic effect was described in a previous paper[1] and is not discussed herein. Suffice it to say that major changes in fuel chemical composition, and volatility, gave no significant change in noise levels.

Since the variables listed above would not necessarily be independent in nature, a factorial-type experiment was designed so that possible interactions between the variables could be evaluated. This experiment is described by Table V which also includes the data that were obtained. A prime consideration was to determine if some change or a combination of changes could be made by the manufacturer or servicemen so that oil burner noise levels would be lowered.

Lowering Firing Rate Gives Most Noise Reduction—Firing rate had the greatest effect on noise level of all the variables tested. Firing rates of 0.5, 0.75, and 1.00 gph were used since this range brackets the heating requirements of an average house. Noise level decreased consistently with firing rate and typical results are shown in Fig. 7.

The 8 db decrease made possible by reducing firing rate from 1.0 to 0.5 gph (80 F flame) is significant. It is similar to the sensation of leaving a room with a window air conditioner in operation, but still remaining in a close-by room or hallway.

Reducing the firing rates of burners in the field will effectively reduce the noise level and at the same time may give increased efficiency by better utilization of the heat exchanger. The magnitude of this change, however, depends on two factors; the lowest possible firing rate that will supply the house with enough heat, and the firing rate of the burner in question. Noise data were not obtained by reducing firing rates initially above 1.0 gph. While a noise reduction will occur, its magnitude has not been determined.

Narrowing Flame Pattern Also Reduces Noise—Fig. 7 also shows the effect of narrowing the flame pattern from 80° to 30°. The narrow 30° flame was 1 to 5 db quieter than the wide sunflower 80° flame at firing rates of 0.6 and 1.0 gph,

respectively. At lower firing rates the effect of flame pattern disappeared, probably because both lower firing rate and narrower oil patterns are decreasing noise by the same route.

The narrowing of flame pattern is a practical means of lowering combustion noise. Although the amount of noise reduction obtainable is a function of minimum spray angle, two practical limitations exist:

Inside geometry of furnace, and
Burner adaptability to narrower air patterns.

The depth of the furnace must be sufficient to accommodate a long narrow flame and the burner must be capable of providing a narrow air pattern. Close matching of air and oil patterns are necessary for efficient operation. In most cases, air patterns can be matched to narrow oil sprays by using a smaller end cone on the burner. Tests were also made with hollow cone nozzles which gave results similar to the solid type.

Other Changes to Flame Are Insignificant or Impractical Noise Reducers—The variable of excess combustion air was studied at two levels, one representing acceptable operation at 40% and the other representing inefficient operation at 125%. No significant trend was observed. Combustion chambers of different size, shape, and materials of construction were also tested. These consisted of round and square combustion chambers of equal and different cross-sectional area. Stainless steel, soft 2000 F firebrick and a hard prefabricated chamber were tried. All cases had essentially the same noise level of 77 db indicating that combustion chamber characteristics are not critical.

Two "over the fire" draft conditions that can easily be obtained in the majority of domestic installations were used in the variable study. These were the minimum acceptable standard of 0.015 in. H_2O and a much higher setting of 0.05 in. H_2O. Higher drafts are impractical in most furnaces because of the accompanying loss in absorption efficiency caused by air leakage. Although the results were consistently in favor of the higher draft, the noise level reduction was only 2 db, barely above that detectable by the human ear. Because of this small decrease and the lower efficiency of high draft, the use of higher draft is not a desirable method of reducing noise.

In addition to the variables examined in the factorial-type experiment, the effect of flame holders was examined because of a lead that turned up during the pulsation studies. The high speed motion pictures showed that even nonpulsing flames have oscillating flame fronts. Such oscillation or momentary instability generates sound waves which contribute to overall flame noise. Consequently, a series of tests was run with several different types of flame holders, which reduced overall flame noise from 3 to 6 db. However, as mentioned previously, flame holders seem impractical in intermittently operated oil burners. In view of these results, further development work to make the device practical and prevent coke buildup may be worthwhile.

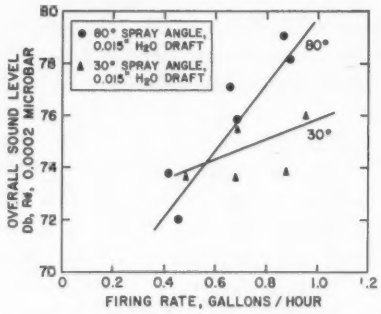


Fig. 7 Non-pulsing noise reduced by lowering firing rate

Findings Can Be Used by Industry – The findings of these studies can be used by equipment manufacturers and servicemen to minimize oil burner flame noise.

By far the biggest noise reduction can be effected by eliminating pulsation. This is accomplished easily and without losing efficiency by using the venting plate. In regard to its use, our studies covered only a small segment of oil-fired installations.

Our results are specifically related to the units tested, but the principle can be applied to oil-fired units in general. These units fall into two classes; new units where manufacturers can modify the equipment before marketing and field installations where servicemen are called upon to correct pulsation.

Manufacturers should follow the same procedure used in the laboratory and discussed in this paper. In brief, test their units with three or four of the most popular makes of burners and determine the venting area required for nonpulsing operation at all operating conditions. Plates can then be designed as part of the unit or as an attachment with sufficient holes to handle all cases.

Servicemen should have two or three plates available: one identical to our test plate and the others with larger venting areas. Simple trial and error in a few installations would supply the necessary experience to minimize future work.

With pulsation eliminated, the noise level is reduced 16 decibels.

In the majority of oil burner installations, however, pulsation does not exist and consequently the noise reduction that the serviceman can accomplish is not as great. By lowering the firing rate and using a narrower spray angle, the flame noise can be reduced 5 to 8 db. Since lower firing rates also provide higher efficiencies, this combination seems desirable. As a result of these changes, the relative loudness of the oil burner was reduced to approximately the same annoyance level as a window air conditioner except that the oil burner is in the basement. Because of the nature of the gun burner in regard to the high air turbulence and unstable flame, any further reduction in noise through simple equipment changes seems unlikely.

REFERENCES

(1) Effect of Fuel Composition on Oil Burner Noise, W. A. Beach, R. W. Sage, H. F. Schroeder, ASHRAE JOURNAL, July 1959.

(2) Noise in the Modern Home, E. E. Mikeska, Noise Control, May 1958.

(3) A Community's Reaction to Noise: Can It Be Forecast?, Stevens, Rosenblith and Bolt, Noise Control, January 1955.

(4) Studies of a Diesel Driven Heat Pump, H. H. Vickers and R. W. Sage, Heating, Piping and Air Conditioning, May 1957.

(5) Low Frequency Combustion Noise in Oil-Burning Equipment, G. J. Sanders and W. C. Lawrie, Heating, Piping and Air Conditioning, October 1958.

(6) Pulsations in Residential Heating Equipment, A. A. Putnam and W. R. Dennis, Heating, Piping and Air Conditioning, July 1956.

Refrigerant drying

requires considerable time before equilibrium is gained

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A primary function of driers in the refrigerating system is to remove moisture from the refrigerant, thus preventing expansion valve or capillary tube freeze-up and minimizing the formation of harmful corrosion products. Because this function is vital to the performance and service life of a refrigerating system, drier installation is standard procedure in field assembly, in many factory built systems or when a sealed system has been opened for servicing.

Accordingly, the desiccants used in various commercially available driers have been the subject of a great deal of study. Recently, for instance, it has become the practice to publish the water capacity of refrigerant driers, defining the water capacity of a desiccant at equilibrium between the refrigerant and the desiccant under given specific conditions.[1,2] This permits the rating of driers by the amount of water they can remove from a system and still assure a satisfactorily low moisture level.

The importance of adequate capacity for water cannot be overemphasized. Not only can "freeze ups" occur, but if the moisture level is disproportionately high, formation of corrosion products is a distinct possibility. At evaporator temperatures of air conditioning applications, other than automotive, the freezing point of water is not attained. Therefore, a system may be operating with a moisture content at which corrosion products may form and still not give indication that an aggravated condition exists by means of a freeze up.

Yet, despite the accepted importance of driers and the extensive study of their absolute water capacity, little work has been done to investigate the factors affecting the time required to reduce the moisture level of a system.[3,4] The drying process is not instantaneous,[3,5] and an understanding of how a given system may be expected to progress from a "wet" to a "dry" state is necessary to help engineers and technicians evaluate drier application.

Presented here are the results of studies of the effects of some of the basic refrigerating system variables on the progress of the drying action. These variables are (1) the rate of flow of the refrigerant, (2) the internal area of the refrigerating system, and (3) the size of the

Little work has been done to investigate the factors affecting the time required to reduce the moisture level of a refrigerating system with desiccant type driers. Here are the results of studies of the effects of some of the basic refrigerating system variables on the progress of the drying action.

Presented also is a practical recommendation designed to remove moisture and to protect the system against freeze ups and formation of corrosion products.

W. O. Krause is Refrigeration Research Chemist, Development and Design, A. B. Guise is Director of Development and Design and E. A. Beacham is Manager, Refrigeration Sales Development, Ansul Chemical Company. This paper, here slightly condensed, was presented as "Time-Factors in the Removal of Moisture from Refrigerating Systems with Desiccant Type Driers" at the ASHRAE 67th Annual Meeting, Vancouver, B. C., June 13-15, 1960. The complete paper will appear in TRANSACTIONS.

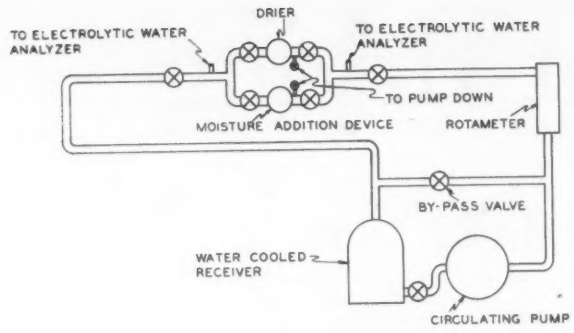


Fig. 1 Circulating system used for rate of drying investigation

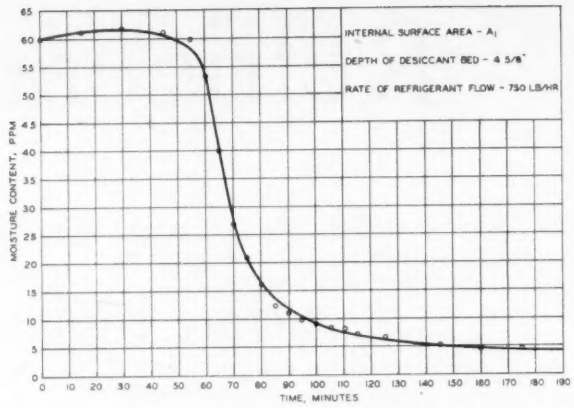


Fig. 2 Typical drying curve obtained with test equipment

drier or depth of desiccant bed.

It is recognized that other variables exist such as particle size and type of desiccant, temperature, and type of refrigerant, but influences of these variables are not included here.

OPERATION OF SYSTEM

To perform these experiments, a simple system with an internal surface area of A_1 as shown in Fig. 1 was assembled and operated under carefully controlled conditions. Refrigerant 12 was circulated through the system and a parallel arrangement of the drier and moisture addition device permitted stabilization of the system at a given moisture level before beginning observation of drier action.

The moisture addition device used was a saturated drier. It was found that pre-loading a drier containing 420 g desiccant with 128 ml of water in accordance with ASRE Standard 35B[1] would "charge" the system to an equilibrium level of 60 ppm of water. This level, representative of an aggravated moisture condition, was maintained as the starting moisture content for the entire series of experiments.

Further, equilibrium of the system at the 60 ppm level was carefully assured before each data run by prolonged operation of the system without the addition or removal of moisture. Taps for electrolytic analysis of moisture content of the refrigerant stream were installed immediately upstream and downstream of the drier.

With the system in operation, the progressive effect of drier action on refrigerant moisture content was first observed with the result shown in Fig. 2. Moisture readings had been taken at the upstream tap.

Note that the moisture content of the refrigerant is actually seen to rise for a period of time after the drier has been placed in operation. This somewhat surprising effect may be explained when it is remembered that the moisture carried in the refrigerant stream is only a portion of the total moisture in the system. A certain amount of moisture will always be adsorbed by the internal surfaces of the system itself in a proportion determined by the relative tendency of the refrigerant to dissolve moisture balanced against the tendency of the system internal surfaces to adsorb moisture.[6,7]

As the temperature of the refrigerant rises slightly when the drier first begins to act, the heated refrigerant has a greater capacity for moisture and the internal surfaces have a reduced moisture capacity. The net result is a slight, temporary increase in the observed moisture level of the refrigerant.

The temperature rise of the refrigerant as it begins to flow through the drier is due to both heat of adsorption of refrigerant in the desiccant material and the increased energy necessary to maintain the same rate of refrigerant flow with the added resistance of the drier.

Once this initial rise in moisture level has been overcome, the moisture content of the refrigerant falls off rapidly as dry refrigerant, emerging from the drier, scavenges surface adsorbed moisture from the system. The level at which equilibrium is reached, of course, depends on the relationship between the absolute moisture content of the drier in use and the absolute moisture content of the system.

To confirm this observation of the progressive effect of drier action, similar tests were run on typical operating open type refrigerating systems. The results of these tests are shown in Fig. 3. Note that the curves display the same general characteristics of drier action as observed in the test system.

More important, perhaps, than the general confirmation of the basic test system, the actual operating unit curves of Fig. 3 point out the detailed differences in the progress of drying action that can occur when rate of refrigerant flow, size of system and size of drier are varied. Each of these variables influences drying time by affecting the progress of the drying process.

EFFECT OF FLOW RATE VARIATION

To isolate and investigate the effect of rate of refrigerant flow on drying action, it was only necessary to vary the flow rate in the test system while holding the internal area of the system and the drier constant. Variation in flow was achieved by means of a by-pass.

Fig. 5 shows the results of tests conducted in this manner. In Fig. 4, the same data are plotted against a logarithmic ordinate to derive a straight line function between rate of refrigerant flow and the reciprocal of the drying time.

For a given drier size and internal surface area, the rate at which a system is relieved of its moisture is increased with increasing rate of refrigerant flow. The

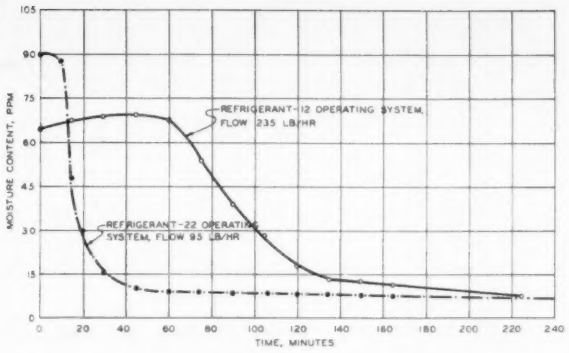


Fig. 3 Typical drying curves for operating systems

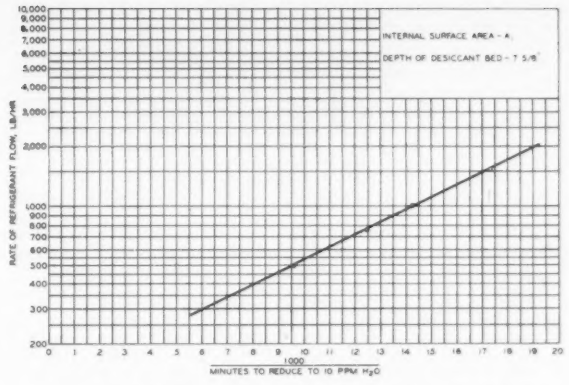


Fig. 4 Effect of rate of flow on drying time with drier and system held constant

dry refrigerant leaving the drier picks up moisture from the internal surfaces of the system and brings it to the drier. The faster the flow, the more cycles the refrigerant can make in a given period of time and the moisture in the system is more rapidly transferred to the drier.

This general relationship holds, of course, only over a practical range of flow rates. As indicated in Fig. 5, extremely fast flow tends to pass the refrigerant through the drier so quickly that the desiccant does not have time to work effectively. Also, below a certain critical rate of flow, drying time is extended disproportionately by any further decrease in flow rate.

EFFECT OF INTERNAL SURFACE AREA VARIATION

Holding the rate of refrigerant flow and drier size constant in the test system while varying the internal surface area produced the results shown in Fig. 6. The increase of internal area of the system was accomplished by adding 50-ft lengths of ⅝-in. copper tubing to the refrigerant flow circuit. Each length of this tubing added approximately 7.4 sq ft of internal surface area; 150 ft were added.

For each additional 50 ft of tubing installed in the system, 7.5 lb of Refrigerant 12 had to be added to the total amount of fluid in the system. Despite this increase in the amount of refrigerant circulating, little additional water was required to bring the system to its initial wet condition at a 60 ppm level. Calculations show that at 60 ppm water 7.5 lb of Refrigerant 12 contains only 0.2 g water.

This indicates that, while a larger system takes longer to dry, the extension of drying time is primarily due to an increase in internal surface area with additional moisture adsorbed by the internal surfaces. Thereby, a removal of larger quantities of water is required.

As the refrigerant passes through the desiccant bed, it is dried to a lower moisture level than when it entered the drier. As it leaves the drier, it contacts the internal surfaces of the system which were in a state of moisture equilibrium with the refrigerant at a higher moisture level. Adsorbed moisture from the system surfaces is then given up to the refrigerant as it flows along until it is again wetted to the point of equilibrium with the internal surfaces.

Thus, it appears that a "dry front" is continuously moving through the system downstream from the drier as the drying process proceeds. This dry front will eventually reach the upstream side of the drier, at which time the drying process is complete.

The length of time needed to reduce the entire system to a low moisture level will be greater or smaller in proportion to the variation in the distance that this dry

Fig. 5 Effect of rate of flow on drying time with drier and system held constant

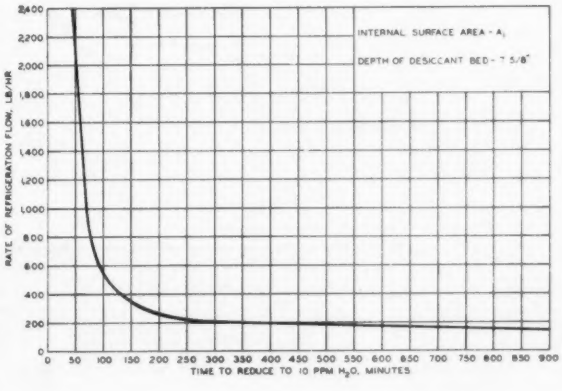
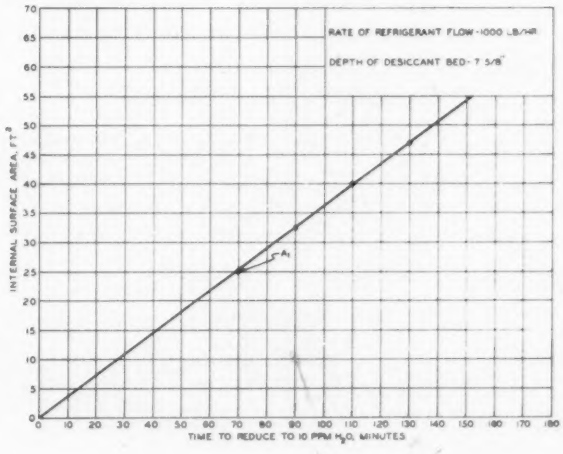


Fig. 6 Effect of increasing surface area on drying time with drier size and flow rate held constant



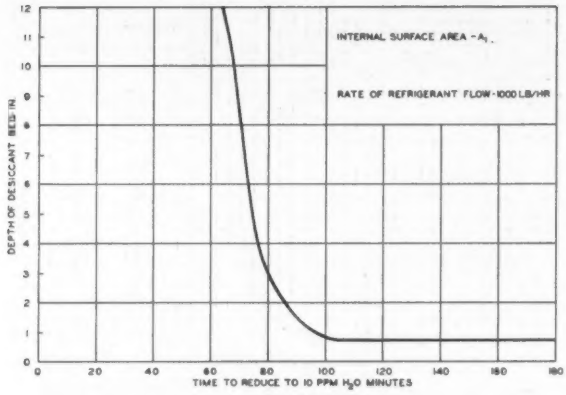


Fig. 7 Effect of depth of desiccant bed on drying time with rate of flow, system size and drier diameter held constant

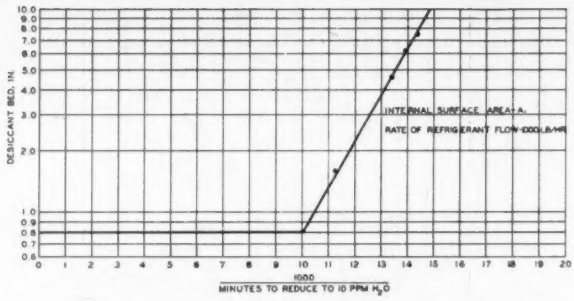


Fig. 8 Effect of depth of desiccant bed on drying time with rate of flow, system size and drier diameter held constant

front must travel, or in proportion to variations in the internal area of the system.

EFFECT OF VARIATION OF DRIER SIZE

Holding the size of the system and the rate of refrigerant flow constant permits isolation and study of the effect of variations in drier size on drying time. Actually, the significant variation here is in the depth of the desiccant bed through which the refrigerant passes.

Fig. 7 shows that the deeper the desiccant bed in a drier, the more rapidly the moisture will be removed at a given flow rate. Fig. 8 shows these data plotted against a logarithmic ordinate to derive a straight line function between the depth of desiccant bed and the reciprocal of the drying time. It was observed further that the slope of the typical drying process curve as shown in Fig. 2 becomes steeper as the depth of the desiccant bed is increased.

This demonstrates the importance of contact time of refrigerant with desiccant bed. The longer the contact time, the more thoroughly the refrigerant will be dried during its passage through the drier. Since a lower moisture content in the refrigerant leaving the drier means more efficient scavenging of adsorbed moisture from the internal surfaces of the system, overall drying action is faster.

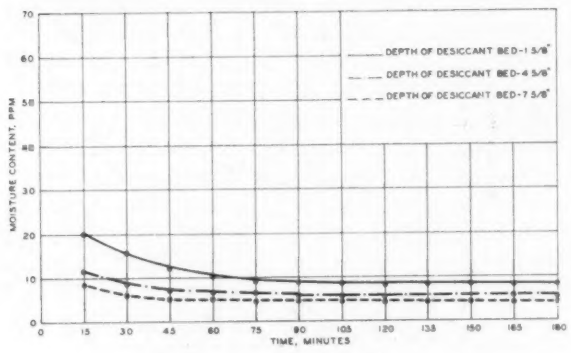
Fig. 9 offers additional supporting evidence that the depth of desiccant bed has an important influence on the rate of drying. As seen from these curves, both the rate of drying and the initial degree of dryness of the effluent refrigerant is related to the desiccant bed depth.

Field experience has consistently shown that over-sizing of driers on wet systems is more effective in preventing freeze ups at the flow control during the early phases of the drying process than the use of a smaller correctly sized drier.

As refrigerant at a certain moisture level enters the drier, it contacts the desiccant bed and begins to give up moisture, becoming progressively drier until it leaves the desiccant bed. As the flow of wet refrigerant continues to enter the drier, the desiccant at the entrance will pick up more water, until it reaches a point of equilibrium with the incoming refrigerant and can no longer exert a drying effect.

This saturated and equilibrated portion of the desiccant bed will move gradually toward the exit end of the drier as a "wet front", so that the remaining capacity of the drier for effective moisture removal becomes progressively smaller. Finally, as the wet front reaches the exit end of the drier, the moisture level of the refrigerant leaving the drier will be the same as that of the refrigerant entering the drier and a condition of moisture equilibrium will exist between the desiccant and the refrigerant.

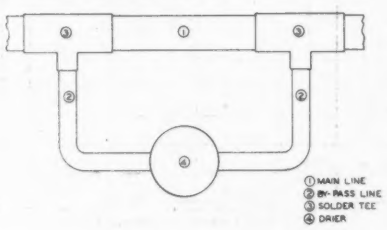
Fig. 9 Effect of drier size on moisture content of effluent Refrigerant 12 with refrigerant flow of 1000 lb/hr and internal surface area of A_1, + 14.8 ft²



ADDITIONAL DATA

To complete this study, two additional experiments concerning drier action under frequently encountered field situations were per-

Fig. 10 Example of drier installed in by-pass



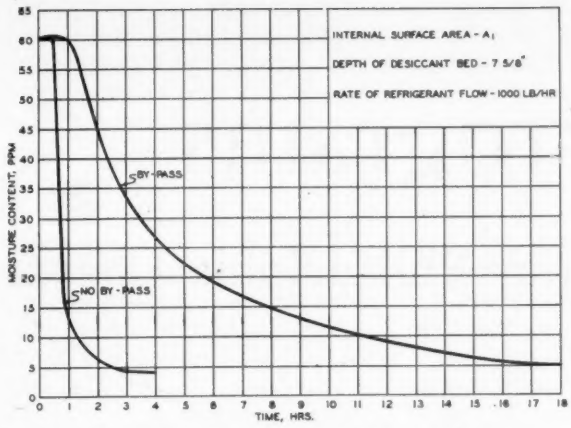


Fig. 11 Effect of installing drier in a by-pass

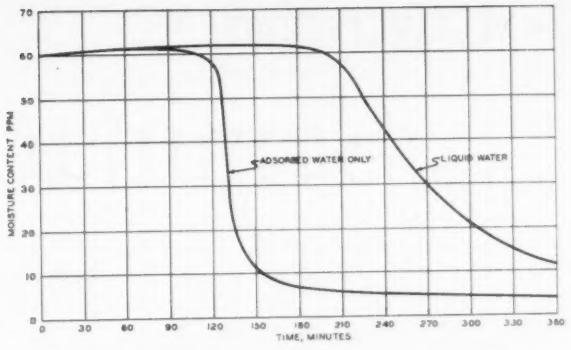


Fig. 12 Effect of liquid water in the system on drying time using a drier with 7⅝ in. depth desiccant bed, internal surface area of A_1, + 22.2 ft² and a rate of flow of 500 lb/hr

formed, one where the drier is installed in a by-pass and the other where liquid water is present in the system.

Fig. 10 shows a typical by-pass drier installation, as used generally on large tonnage equipment where the line sizes are bigger than the connector sizes of the readily available driers. When the refrigerant reaches the upstream tee, the stream will divide. A proportionate amount will go through the drier, depending on the ratio of the pressure drops in the two possible channels of flow between the tees.

This "fractional flow" of refrigerant through the drier naturally has the same effect as reducing the rate of flow in the system and increases drying time. However, assuming a drier of adequate capacity, this is the only effect on the progress of drying action which proceeds normally, as shown in Fig. 11. The size of the main line between the by-pass tees can be reduced to improve drying time.

When improper dehydration procedures are used before equipment start up, liquid water may be present in the system. Fig. 12 presents the drying curve for a system containing liquid water. Approximately one fluid ounce of water was added to the test system for this study and the largest size drier available was used to assure ample capacity.

It is assumed that the liquid water in the system found its way to the receiver where it floated on the surface of the refrigerant or adhered to the walls of the receiver. Experience with glass equipment recirculating Refrigerant 11 has shown that when liquid water is present it clings to the system walls in small globules. Here it dissolved into the refrigerant, rather rapidly at first and then more slowly as the saturation level was approached.

It was noted that the moisture content of the refrigerant did not reach the saturation value of 110 ppm although the refrigerant was cycled for 18 hr previous to observing drying action. Experience has shown that when less than saturation values are desired, thorough agitation for 72 hr is needed to assure complete solution of the liquid water added to the refrigerant.

Except as noted, liquid water in the system showed no marked effect on drier action.

CONCLUSION

The action of a drier in a given refrigerating system requires a considerable period of time to bring the moisture level of the refrigerant to a state of equilibrium with the drier.

The actual time required will vary with the rate of refrigerant flow, internal area of system and size of drier. In general, the time required to dry systems with low rates of refrigerant flow will take longer than those with high flow rates. A larger drier will dry a system more rapidly than a smaller drier. With the same basic components, remote systems will take longer to dry than packaged units because of greater internal surface area.

Observations in the course of these investigations also lead to a practical recommendation. Because that part of the refrigerating system which is closest to the outlet end of the drier will be reduced to a low moisture level almost as soon as the drying process begins, the drier should be installed as close upstream to the expansion valve or capillary tube as possible. Thus, one of the sensitive parts of the system as far as moisture is concerned will be in the "dry zone", well before the entire system is dry. This assures immediate and continuing protection against freeze-ups, regardless of drying time required, as long as drier capacity is adequate.

In a system a large drier will reduce the moisture content to a lower degree and in a shorter period of time than a small drier. Accordingly, the possibility of freeze ups and formation of corrosion products due to moisture are minimized.

Drying time data obtained in the course of this investigation will not necessarily hold true for systems in the field. Rather, the data presented here indicate what to expect when the care taken in equipment dehydration before start-up and the nature of the installation itself are considered.

REFERENCES

1. "Methods of Rating and Testing High Side Liquid Line Driers", Standard 35, part B, (American Society of Refrigerating Engineers).
2. "1958 ARI Standard for Liquid Line Driers", Standard 710, Air-Conditioning and Refrigeration Institute.
3. Sterk, B. J. "Certain Test Results for Three Desiccants in a Freon-12 System", Refrigerating Engineering, 57 No. 8, 782 (1949).
4. Pennington, W. A. "Role of Adsorption—Type Desiccant in Refrigeration Units", Refrigerating Engineering, 59 No. 3, 272 (1951).
5. Walker, W. O. and Willson, K. "Refrigerant Driers", Ansul News Notes, 1 No. 3, pp. 1-7 (1937).
6. Brisken, W. R. "Moisture Migration in Hermetic Refrigeration Systems as Measured under Various Operating Conditions", Refrigerating Engineering 63 No. 7, 42-48 (1955).
7. Krause, W. O. "Adsorption of Moisture by Cylinder Walls", Ansul News Notes, pp. 8-9 (June 1953).

How diversified

Seminar programs

benefit our Philadelphia Chapter

WALTER F. SPIEGEL
Member ASHRAE

One of the challenges of a newly merged chapter is to provide and to plan stimulating meetings of interest to members. Here, Walter F. Spiegel tells how the Philadelphia Chapter has benefited from a well planned sponsorship of heating and refrigeration seminars and technical pre-dinner sessions that were geared to a wide diversity of interests; reveals how this was accomplished; and indicates the tangible results achieved.

To meet the demand of young engineers for opportunities for a more basic technical discussion than could be held at regular chapter meetings, educational pre-dinner sessions were started in 1950, in the ASRE Section. This program was inaugurated by having notable local engineers prepare half-hour orientation talks; their presentation was usually followed by three quarters of an hour of "free-for-all."

This concept of education led to the present full scale program of the Philadelphia Chapter.

1. Pre-dinner educational sessions at the monthly chapter meetings of a basic, fundamental and informal nature on specific limited areas of interest. Generally, two different, concurrent sessions are scheduled.

2. Two annual, all-day "Seminars" with several presentations, demonstrations, and long question periods. One seminar, held in the fall, is on the general subject of heating. The other, in the spring, is on the general subject of refrigeration. The seminars are publicized throughout the industry in this area, and are attended by many old-timers as well as young engineers and technicians. The last seminar had an attendance of over 200, including the Regional Director and 2nd Vice President of the Society.

It was at one of the educational sessions that the idea of the seminar originated. In 1952, one of the scheduled speakers was unable to be at one of the sessions and two officers of the Section discussed with the audience what was wanted in the way of a program. The answer—a whole day devoted to refrigeration fundamentals, preferably on a Saturday. The first refrigeration seminar proved the idea to be successful. The program covered basic refrigeration components, and was attended by more than 100 people. The seminar was repeated each year with somewhat varied approach. When the ASRE Section and the ASHAE Chapter merged in June 1959, the prospect of two individual seminars and specific interest, pre-dinner sessions was a large factor in retaining members from the fringe interest industries. These included heating specialties, commercial refrigeration and others who might not be served by the broad base programs which were destined to be the sole type of interest to the majority of the new combined membership.

Last year, for example, discussions were held on such diverse subjects as steam trap application, development of a 160-ton thermoelectric air conditioning plant, liquid refrigerant circulators, and heating pumps. The latter generated such controversy of water treatment vs. mechanical seals, that this topic is now being considered for one of the regular chapter meeting technical sessions next season.

The seminar has been expanded into two separate all-day sessions each held in the Huston Hall Auditorium of the University of Pennsylvania. The heating seminar is given on the Saturday before Thanksgiving and the one on refrigeration is held in March. The program consists of five prepared presentations, each lasting an hour, including a 20 minute question period. The program starts at 9:00 AM and is concluded at 3:00 PM. A nominal charge has been made for attendance, to cover the price of lunch, mailing, publicity, etc.

The heating seminar included a discussion of the physiological effect of humidity in heating, psychrometric principles, types of firing equipment, hot water control valve application, and a demonstration of testing instruments.

The most recent seminar, "Refrigeration for Air Conditioning," was designed primarily for the

Walter F. Spiegel is Past President of the Philadelphia Chapter.

members of the former ASHAE Chapter who wanted a briefing on refrigeration. The audience of 210 people included suppliers who had recently expanded their lines to include refrigeration equipment, and young engineers, technicians and foreign students desiring basic orientation.

The first speaker was Melvin Wind, of Carrier Corp., who described some of the basic principles of refrigeration. His presentation included an actual demonstration with a vacuum pump to illustrate the effect of water in a refrigerant. This was followed by Michael Pelosi, who discussed the basic components of DX systems and of the newly developed assemblies for commercial and residential systems. Fred Manget, of Trane Company, outlined some of the basic recent developments in packaged water chillers and discussed the preferable way to control this type of equipment when applied to various systems. Ken Wicks, of Marlo Coil Company, illustrated the basic do's and dont's of chilled water coil application: a review resulting from extensive experience.

In the final presentation, Walter Staats of West Jersey York related some of the guiding principles for successful start up and operation of refrigeration systems, and Francis House of Mueller Brass Co. gave actual demonstrations of proper brazing procedures including the use of several recently developed materials. After the formal adjournment, over half the audience remained for a further question and answer period.

Much of the success of the seminars was due to careful planning. Extensive committees decided on topics and speakers approximately three or four months prior to the date of the seminar. At that time, arrangements were made for facilities and tickets printed. A month or two before the seminar, a meeting of all the speakers was held and the preliminary material reviewed jointly to avoid overlaps and omissions from the planned sequence. At that meeting, the topic designations were made final, posters printed and distributed, announcements mailed, and tickets dispersed, with large blocks issued to members of the Board of Governors for personal distribution.

Announcements of the last seminar were also mailed by local wholesalers and suppliers with their monthly invoices, and blocks were sent to other organizations. Tear-off blanks at the bottom of the announcement made it convenient to mail a request for tickets.

Large contractors, etc., were also contacted. Two weeks before the seminar, an accurate ticket count was started and holders of ticket blocks were encouraged to submit receipts and to continue to sell tickets. Ten days before the final date, about 1/3 of the tickets finally sold had been reported. The final estimate prepared on the day previous to the seminar was within 5% of the actual figure, with sales at the door approximately equal to the "No Shows."

Comments after the two seminars were extremely favorable and expenses were more than covered. Many new membership inquiries and applications were received and the Philadelphia Chapter is more than convinced that its educational program is a major factor for this Society's being a focal point of the Heating, Refrigeration and Air Conditioning Industry in the Delaware Valley.

IIR holds series of meetings

The International Institute of Refrigeration has conducted a number of commission meetings during the summer of 1960. These started with that of Commission 1 on Cryogenics in Eindhoven, Holland, June 28-30. Among representatives of the United States who participated were Dean F. G. Brickwedde of the Pennsylvania State University and Dr. R. B. Scott of the Cryogenic Engineering Laboratory of the National Bureau of Standards in Boulder, Colo.

This meeting was followed by one of Commission 2 held in Belgrade, Yugoslavia, under the Chairmanship of its President, Professor Carl F. Kayan of Columbia University. Three technical sessions were held, comprised of eleven papers of which four were contributed by U.S.A. authors. In its regular business session the Commission laid down the plans for its program for Comparative Testing of Thermal Insulation Samples by different representative laboratories throughout the world. This program, proposed by former president Dr. Ezer Griffiths, until recently attached to the National Physical Laboratory at Teddington, England, had been previously voted for sponsorship at the Commission meeting in Prague, Czechoslovakia. It is expected that several laboratories in this country will participate in the program, based on insulation samples supplied from England through the Commission's active committee.

In addition to the regular meeting of the Technical Board called in Belgrade, Commission 9 of IIR also conducted a program on Refrigeration Education, dealing with some of the problems confronting Yugoslavia in this field.

Commission 3 (Design, construction and operation of machinery for refrigeration and air-conditioning plants), Commission 4 (Application of refrigeration to foodstuffs and agricultural produce), and Commission 5 (Cold stores and ice-making plants) will hold their annual meetings in Marseilles September 7-10, in association with the French Society of Refrigeration. Among the many papers which will be presented, there will be at least two from the United States as J. R. Chamberlain of York, Pa., and Edward Simons of San Francisco are included on the program.

There was a Cryogenic Engineering Conference at Boulder, Colo., August 23-25. This was organized by the Cryogenic Engineering Conference jointly with the National Bureau of Standards and the University of Colorado.

The United States National Committee of the International Institute of Refrigeration which acts under the sponsorship of the National Academy of Sciences-National Research Council has been active in coordinating the participation of the U.S.A. in these international activities. This Committee serves under the Chairmanship of Professor R. C. Jordan of the University of Minnesota.

Ducts of asbestos – cement, with unobstructed joints and smooth surfaces, have

30% lower pressure drop

D. W. FRENCH

T. R. GILLEN

There has been a lack of test data in regard to pressure drop within asbestos-cement air ducts to meet the engineer-designer's needs that accompany the increasing number of such installations for perimeter warm air heating systems. The 1960 ASHRAE GUIDE contains charts (page 294, Fig. 2) which give friction loss in inches of water per 100 ft based on sheet metal ducts.

To provide similar information in chart form, pressure loss tests have been performed recently at the Johns-Manville Research Center on galvanized iron duct, to correlate earlier test work, and then on asbestos-cement air duct. Tests on galvanized iron duct in 2 ft lengths with crimped joints were made using equipment and procedures developed and employed in earlier work by A. B. Algren and L. M. Fingerson, both of the University of Minnesota, and in cooperation with the National Warm Air Heating and Air Conditioning Association. The results with the galvanized iron run at the Research Center showed close correlation with those found by the investigators at the University of Minnesota.

These tests were then followed by similar ones using 10 ft lengths of sizes 6 and 8-in. asbestos-cement air duct leaving inside diameters equal to the respective sizes and with the ends butted and with outside connectors.

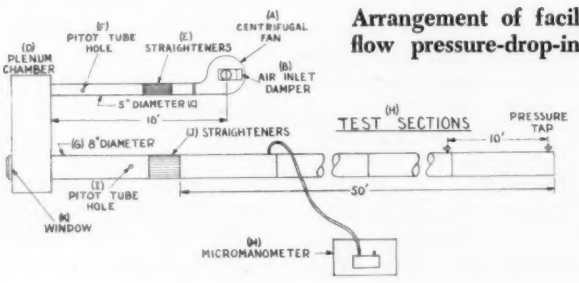
Apparatus used – Facilities for the tests of both galvanized and asbestos-cement were constructed (Fig. 1) as follows: A centrifugal fan (A) with a direct drive motor was used with an air inlet damper (B) for air volume variation. A 5-in. diam duct (C) was connected the 10 ft distance between the fan and the plenum chamber (D). This duct contained straighteners (E) located 2 ft downstream of the fan and a pitot tube opening (F) 10 duct diameters (50 in.) downstream of the straighteners. An 8-in. diam duct (G) connected the plenum chamber to the test sections (H). This also contained a hole (I) for the pitot tube traverse 10 duct diameters (80 in.) downstream of the plenum. The plenum chamber served to mix the air and had windows (K) opposite the duct entrance to facilitate pitot tube alignment. The straighteners (J) located at the entrance to the test sections and which completely filled the duct were ¾-in. copper tubes, one duct diameter (8 in.) long.

Thirty-foot, ⅜-in. diam rubber hoses were used to make the connection between the pressure taps (L) and the stationary micromanometer (M). A comparison check for pressure loss with a 3-ft hose showed a variation of less than 0.00025 in. H_2O. This was considered negligible since readings this small are not reproducible because of the human element. Also, the method of determining velocity was checked. A 9-point traverse, both horizontal and vertical, was compared with the standard 3-point traverse on both the horizontal and vertical diameters at 9 different flow rates. The velocity check between the 3-point and 9-point velocity traverse indicated there was less than 1 per cent variation in the averaged flow rates calculated from the data of the two traverses.

Pressure taps were located every 10 ft along the 50 ft test section and were installed on the horizontal center line perpendicular to both its longitudinal axis and tangent line. A 1/16-in. hole was drilled and the burrs were removed; then a short ⅛-in. diam copper tube was either cemented or soldered in place. A short clamped hose was kept on this tap except when the manometer hose was attached for readings.

The micromanometer was simply a pair of connected reservoirs filled with water, the surface of which was dimpled by the needle points of micrometer heads.

Test procedure – Air flow, varied by the damper at the fan inlet, was regulated in 8 to 10 graduations, each of which constituted a run. An estimate of the velocity at each graduated setting was read directly in fpm on a velometer at the exit end of the test section. A micromanometer was used



Arrangement of facilities for air flow pressure-drop-in-ducts tests

D. W. French is Research Engineer, T. R. Gillen is Assistant Manager of Engineering, Johns-Manville Corporation, Pipe Div.

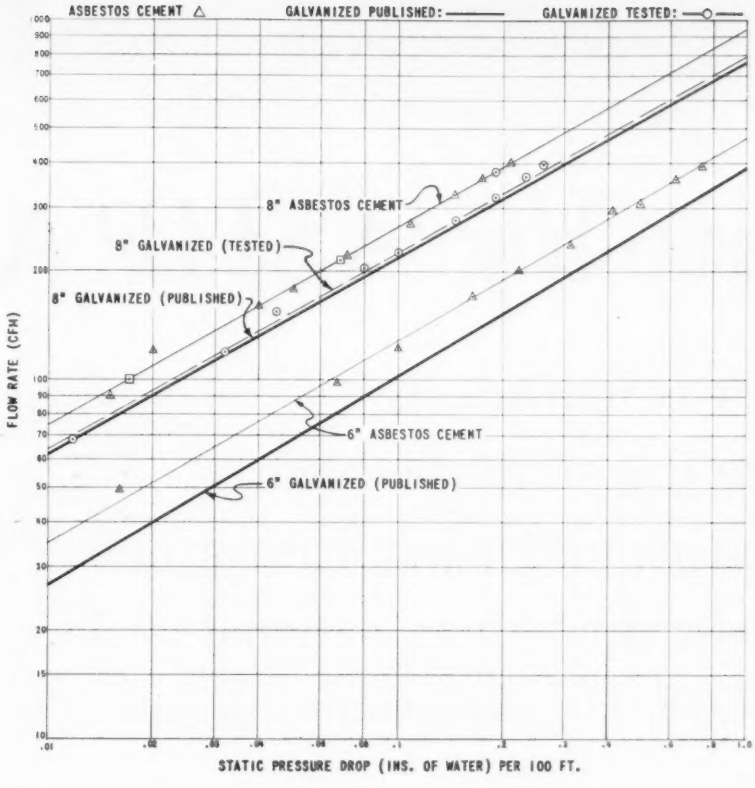


Fig. 2 Velocity vs. static pressure drop

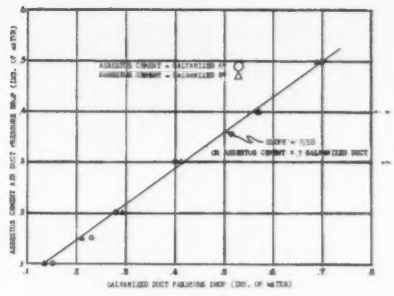
to read all pressure changes, the zeros being recorded before each run. Nine sets of pressure readings were subtracted from the zeros for each run. A 3-point pitot tube traverse, on the horizontal diameter of the duct, provided pressure difference data from which the average velocity or flow rate could be calculated. To measure the pressure drop in 50 ft of duct, static pressures at the beginning and approximately every 10 ft along the straight test length were recorded. Thus, for each run there were three left and right sets of micromanometer readings from the pitot tube traverse, and six sets of readings from each of the static pressure taps.

The differences between the static pressure readings at each of the six taps and the zeros for that run were obtained. The distance along the test section was marked off in feet starting at the tap just downstream of the pitot tube. Thus, each of the static pressure differences could be plotted against the tap's respective position along the test section.

Test results – It was indicated that asbestos-cement air duct compares quite favorably with galvanized iron duct. During the tests conducted on the two types of straight duct, the air flow rates were varied from 40 cfm to 400 cfm. For each flow rate, the curve of static pressure versus distance was plotted primarily to detect any erroneous micromanometer readings, misalignment or obstruction in the flow stream. The slope of the curve was interpreted as the pressure drop (in. H_2O) per 100 ft of duct length. Thus, for each of the 8 or 10 flow rates there was determined a corresponding constant rate of pressure drop.

These 8 or 10 constants were plotted against their corresponding flow rates for both the 6 and 8-in. sizes of asbestos-cement air duct (Fig. 2). The test results for the 8-in. galvanized iron were plotted on this graph as a correlation check along with the published 6 and 8-in. galvanized iron duct curves. To directly compare the two types of duct, the pressure drop constant for asbestos-cement at specific flow rates was plotted against the pressure drop constant for galvanized iron duct at the same flow rates (Fig. 3). From the slope of this curve the following results are evident:

Asbestos-cement has up to 30% less pressure loss than did galvanized duct.

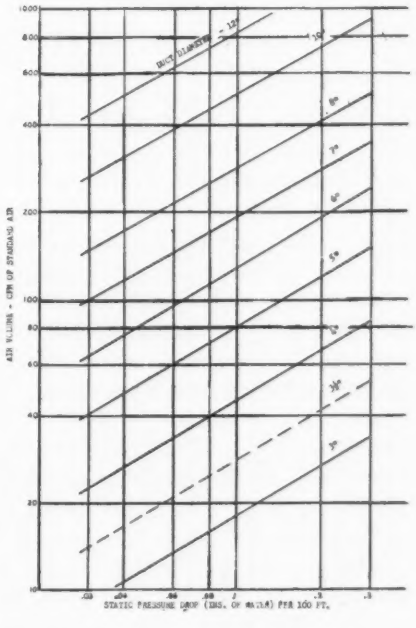


Pressure drops within ducts compared
(Note: Both the circled points for the 6 in. comparison and the triangled points for the 8 in. comparison follow the same line in Fig. 3.)

Fig. 3

Fig. 4

Extrapolated data for straight asbestos-cement air ducts



Results are consistent regardless of the diameter of the air duct tested.

CONCLUSIONS

Asbestos-cement Air Duct with full inside diameters has as much as 30% lower pressure drop than does galvanized iron duct. The crimped joints of the galvanized duct neck down, project into and obstruct the flow stream. In addition, the fewer joints and the smoother wall cut down on

(*Continued on page* 110)

Recent research center tests upon asbestos-cement ducts, for perimeter heating air distribution, indicate consistently better performance than for galvanized iron duct because the former minimize internal air friction by inherent design or surface characteristics.

PRESIDENT'S PAGE
JOHN EVERETTS, JR.
Guest Sponsor

Solutions for ASHRAE

— each Chapter is individual
— programs are the major problem
— make new members a part of the group
— encourage participation in national affairs
— keep ASHRAE Headquarters informed

In any membership organization, be it community, civic, or professional, the pattern of local organizational problems is quite parallel. They are basically: 1 – programs, 2 – finances, 3 – attendance, 4 – membership, 5 – national participation and 6 – communications. These are not necessarily in order of importance.

For some chapters in our Society finances and membership may be more important than programs or attendance. Each chapter is individual in its thinking, operation and methods of approach to the fundamental precepts and aims of the Society as a whole. This is as it should be for a society of the intellectual caliber of ours.

Programs seem to head the list of local problems (as well as national meetings), regardless of chapter size, location or major interests. A report is now being prepared giving a number of suggestions for Program chairmen to consider for their schedule. The details are too numerous to expand in this short dissertation. Your Regional Director should have this report by the Semiannual Meeting in Chicago.

Finances are as varied as the number of chapters. A recent survey showed that meeting notices ran from 10 to 40c per man per meeting. Golf prizes, souvenirs for the ladies at the Christmas Dance, and bar deficits are considered sometimes as operating expenses with requests to Headquarters to increase chapter allowances to cover these items, but chapter allowances are for basic operating expenses for notices and for conducting a meeting. Dances, golf-outings, etc., must be self-sustaining.

Many chapters find they can budget their operations to stay within the allowance. Other chapters find that additional dues are necessary to keep solvent. This is a problem the Regions Central Committee must resolve with the cooperation of the chapters. There are undoubtedly certain cases where the allowance is inadequate. There are many other cases, however, where a thorough overhaul of the fiscal operations of a chapter can result in a reduction and possibly elimination of chapter dues.

Attendance at chapter meetings is dependent upon: 1 – the program, and 2 – the attention paid new members. The program is set by the Program Committee and can be either good or bad. A new member who is ignored by the "regulars" very rapidly becomes an absent member. Check your meetings against your new members list of the past year. Has the attendance increased in proportion to the new members or is it still the same number? If it is still the same number, are the new members in attendance or is it the same old gang who have their own little private cliques and groups?

Increase in chapter attendance requires that new members be made a part of the group. If they are not suitable to be a part of your group, then they should not have been processed as Society members in the first place.

Membership development in a chapter is automatically left to the Membership Committee and if that committee is strong, then a favorable increase in membership will result. If the committee is not particularly active, the net results at the end of the year due to normal attrition may be negative. To build a strong, healthy chapter, every member of the chapter should consider himself a part of the Membership

Chapter Problems

JOHN EVERETTS, JR.
Second Vice President
ASHRAE

Committee and do all he can to interest qualified prospects in becoming members. The Membership Committee, per se, should be the one to get the prospect to sign on the dotted line after you have warmed him up. After he has signed the application, don't drop him and let him get cold – keep him warmed up and you will have an active and interested member.

When a National officer or Regional Director visits a chapter, one of the questions usually asked is: "How can we participate in National affairs?" There are several ways, provided the chapter will cooperate. There are the Annual, Semiannual, and Chapters Regional meetings which require a great deal of help by the local membership. There are also many committees which are necessary for the proper operation of the Society and they must be manned by competent interested members who are willing to dedicate their time and effort to this work. There are administrative committees, technical committees, general committees, and special committees. For some of these committees, such as Nominating, Chapters Regional, Research, etc., the members are elected according to the By-laws. Most other committees the members are appointed by the President.

In order to have an efficient, smooth operating Society, the Nominating Committee and the President-elect must have a source of candidates from which to select officers, directors and committee members. There are over 200 committee appointments which must be made every year and the only source for obtaining candidates is through the chapters. If the chapters will cooperate and submit names and biographies of people who are outstanding in chapter affairs and who would be willing to serve on national committees, the appointment of committees would be a simpler problem than it is at present. The submission of names should be made at the Chapters Regional meetings through the delegates to the Regional Director who will pass them on through the proper channels.

Communication between the chapters and National Headquarters is an essential requirement if the chapters expect to have a strong National Society.

Section 8.8.8 of the By-laws requires the selection of one member and one alternate from each chapter to the Chapters Regional Committee. The Manual for Regions Operation requires that the member and alternate be certified before June 1st of each year. If they are not properly certified, the Regional Director has no alternative but to prohibit them from voting at their Chapters Regional meeting.

Section 9.6 of the By-laws requires that: "Each chapter or branch shall promptly file a copy of its Minutes with the Executive Secretary of the Society and make a report to said Secretary of all its proceedings."

These Minutes serve two purposes: 1 – they furnish Headquarters with current program, finance and attendance data which are analyzed to see how a chapter is progressing, and 2 – they give the JOURNAL Editor many items and ideas to publish under Chapter News in the JOURNAL and provide leads for possible JOURNAL articles as well as National Program speakers. A good "Meeting Report" from your chapter will be welcomed by the JOURNAL staff.

This meeting information is also disseminated to give other chapters program ideas and learn what is going on in other Chapters and Regions.

If you have writing talent, then take a little extra time to write an interesting report. If you don't have talent, write it anyway and the Editor or his staff will see that the pertinent facts are published.

Remember, gentlemen, the association between the chapters and the National organization is a two-way street. Headquarters, the Research Laboratory, and their staffs are in business to help you; however, they need your cooperation so your chapter problems may be resolved efficiently and economically.

Corrosion inhibition

on steel tubes in low-pressure steam boilers

W. A. KEILBAUGH

F. J. POCOCK

A research program, spanning five years, and under the direction of the Engineering Committee of the Steel Boiler Institute, was undertaken to investigate causes and prevention of tube corrosion in low-pressure steel (15 psig max steam) boilers.

Some of the results from this study were reported in an earlier paper.[1] That report described the testing technique and apparatus in detail and reviewed the work performed from test inception until April 1957.

Discussions with the Engineering Committee of the SBI before the investigation indicated that the principal cause of corrosion was dissolved oxygen in the feedwater and boiler water. Since deaeration of the feedwater is neither practical nor economical for the majority of small boilers, nor is the use of chemical oxygen scavengers feasible, due to control difficulties, the general approach to the corrosion problem was a practical one involving the use of anodic chemical inhibitors.

These earlier tests indicated that two chemical inhibitors merited closer examination. They were the Steel Boiler Institute chromate compound and one other proprietary compound which was a sodium borate-nitrate-nitrite mixture. Additional inhibitors were also investigated.

Consideration was given to the use of high strength low-alloy and copper-bearing steels during both parts of the program. Other investigations[2] had indicated that small amounts of copper, as a steel alloying constituent, would have beneficial effects. Researchers compared the corrosion behavior of these low-alloy steels and plain carbon steel tubes made to ASTM-A 178 Grade A specifications.

Test work was carried out in small boilers operating at essentially atmospheric pressures, in order to duplicate as far as possible, under closely controlled conditions, the field operation of low-pressure steel boilers. Experience has shown that the use of coupon material in laboratory bench-scale tests or in autoclaves does not pro-

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Fig. 1 General view of test installation

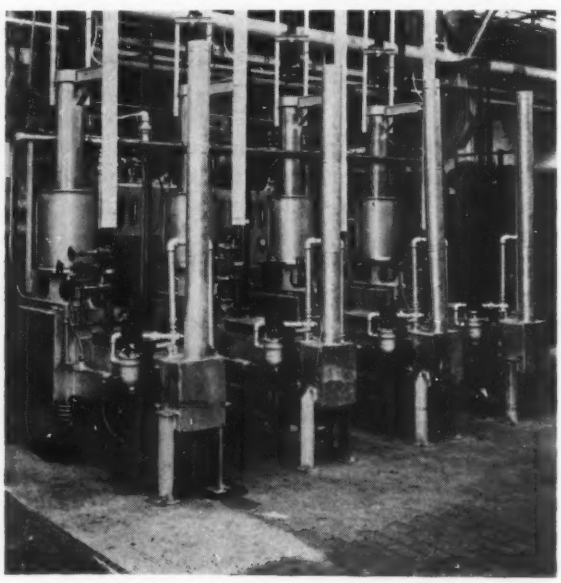


Fig. 2 Schematic diagram of the test unit

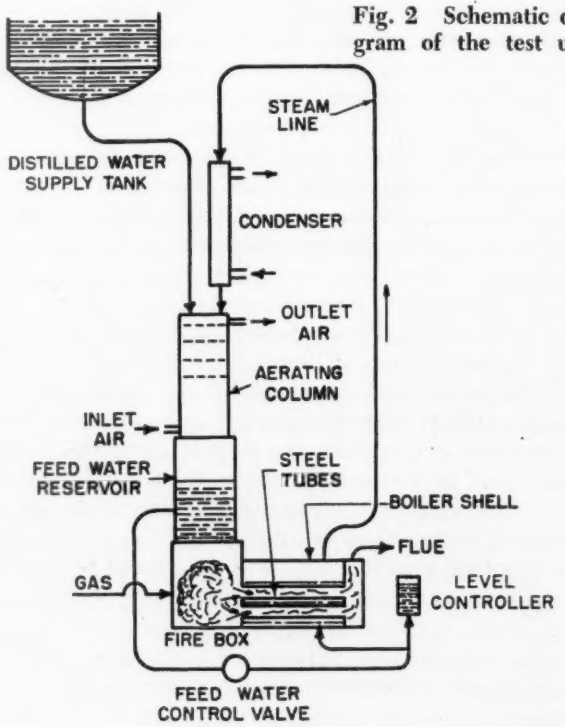


TABLE I—TUBE METAL ANALYSES

Test No.	1 & 5	2	3	4	6	7, 11 & 15	8	9 & 10	12	13[b]	14 & 16	17[b]
						Percent						
Carbon	0.17	0.12	0.12	0.10	0.11	0.17	0.07	0.08	0.12	0.08	0.15	0.11
Silicon	0.01	0.01	0.015	0.01	0.01	0.01	0.01	0.01	0.01	0.36	0.01	<0.01
Manganese	0.35	0.35	0.34	0.34	0.41	0.38	0.38	0.34	0.43	0.29	0.44	0.65
Phosphorus	0.008	0.008	0.010	0.010	0.008	0.013	0.007	0.010	0.010	0.089	0.01	0.010
Sulfur	0.023	0.019	0.021	0.016	0.029	0.037	0.017	0.04	0.05	0.039	0.029	0.027
Nickel[a]	0.059	0.054	0.043	0.045	0.13	0.13	0.13	0.058	0.050	0.28	0.052	1.05
Chromium[a]	0.056	0.052	0.051	0.050	0.05	0.06	0.05	N.D.[c]	N.D.[c]	0.69	0.05	<0.1
Vanadium[a]	0.005	0.005	0.005	—	—	—	—	—	—	—	—	<0.005
Molybdenum[a]	0.008	0.008	0.008	0.008	0.03	0.02	0.03	0.01	0.005	0.008	0.009	0.14
Copper[a]	0.06	0.07	0.08	0.07	0.06	0.06	0.06	0.046	0.064	0.30	0.07	0.98
Aluminum[a]	0.005	0.005	0.005	0.005	—	—	—	0.001	0.002	0.005	0.004	<0.005
Tin[a]	0.006	0.008	0.007	0.007	0.009	0.007	0.008	—	—	—	—	—

Test No.	18, 19 & 20	21[d]	22, 23 & 24	25, 26, 27 & 28			29	30	31	32
Carbon	0.12	0.11	0.10	0.11	0.12	0.11	0.13	0.14	0.16	0.12
Silicon	0.01	<0.01	<0.01	0.008	0.01	0.01	<0.01	<0.01	<0.01	<0.01
Manganese	0.41	0.42	0.39	0.34	0.44	0.40	0.42	0.43	0.44	0.47
Phosphorus	0.009	0.008	0.007	0.008	0.007	0.008	0.006	0.008	0.006	0.007
Sulfur	0.025	0.021	0.016	0.025	0.034	0.023	0.025	0.028	0.027	0.019
Nickel	0.09	0.094[a]	0.13[a]	<0.03[a]	<0.03[a]	<0.03[a]	0.04[a]	0.04[a]	0.04[a]	0.04[a]
Chromium[a]	<0.1	0.010	0.022	0.05	0.16	0.06	0.07	0.07	0.07	0.07
Vanadium[a]	<0.006	N.D.	N.D.	<0.01	<0.01	<0.01	<0.005	<0.005	<0.005	<0.005
Molybdenum	0.012[a]	0.018[a]	0.014[a]	0.02	0.03	0.01	0.03[a]	0.03[a]	0.03[a]	0.03[a]
Copper	0.06[a]	0.37[a]	0.11[a]	0.05[a]	0.17	0.06[a]	0.06[a]	0.06[a]	0.05[a]	0.07[a]
Aluminum[a]	0.005	—	—	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004	<0.004
Tin[a]	—	—	—	<0.01	0.01	<0.01	0.02	0.01	0.02	0.02

[a] Spectrographic Trace Metal Analyses [b] High Strength, Low Alloy Steel [c] N.D. = Not Detected [d] Copper Bearing Steel

duce conditions comparable to field operation, since the effect of temperature resulting from heat transfer through the metal cannot be evaluated.

Along with the boiler testing program, the factors influencing corrosion during boiler storage periods were also considered. It is known that many of the corrosion problems of boilers have their inception during storage.

As a result of these tests, a number of recommendations were made regarding the water side care of low-pressure steel boilers. If the recommendations are carefully adhered to, there should be a general increase in operational reliability of these boilers.

ACCELERATED CORROSION TESTS

Test boiler design—The test equipment for this investigation consisted of four gas-fired steel boilers, each of which had its own feedwater and condensate system.

Each test boiler contained, except as noted later, four three-in. OD by 48-in. electric resistance welded boiler tubes made to ASTM-A-178 Grade A specifications. These tubes were rolled into ⅜-in. carbon steel tube sheets, and each boiler was fired with a conventional 120,000 Btu per hr gas burner.

The boilers operated at essentially atmospheric boiling conditions. The steam is condensed and the condensate is passed countercurrently to air flow through a baffled aerating tower. The air-saturated feedwater is then fed automatically to the boiler as required by the boiler water level controls. Total steam flow for each unit is approximately 50 lb/hr. Steam losses are made up automatically from aluminum storage tanks containing distilled water. Using distilled water as a starting point, water chemical characteristics could be varied as desired.

Automatic timing controls were provided so that the boilers operated in pairs for 30-min firing intervals with an equivalent off period. This simulated as closely as possible the periodic operation of the usual heating boiler.

The boilers were operated 24 hours a day in this manner for the duration of each test.

Fig. 2 shows a schematic drawing of a typical test boiler. Fig. 1 shows a general view of the test installation.

Boiler tubes – All those used in these investigations were electric resistance welded. Except for three tests, the tubes were made to ASTM-A-178 Grade A specifications. Three material comparison tests were made, two using high strength, low-alloy tubes and one using copper-bearing steel tubes. One of the three latter tests was reported in the previous paper.[1]

Tubes are received with a thin film of soluble oil as corrosion protection in transit. They are rolled into the tube sheets of the test boilers in this condition, with only light wiping with cloth and mineral spirits to remove foreign material which is picked up in shipment. In these tests they were not acid cleaned (i.e. pickled).

Chemical composition of the boiler tubes – Representative tubes from each steel heat used in this investigation were analyzed chemically. These steel analyses are contained in Table I.

Base boiler waters – The laboratory distilled water, with a nominal 100 ppm chloride as sodium chloride added, was used because of the wide variations that occur in natural water supplies. The feedwater was air saturated (at 100 F) distilled water.

Table II contains a summary (tests 1-16) of the conditions of these tests as well as those described here (17-32).

Further tests of the selected chemical inhibitors, in the presence of hardness ($Ca(HCO_3)_2$, $MgSO_4$,

$CaSO_4$) in the boiler water, were necessary, since it was felt that these hardness constituents might have some deleterious effect on inhibitor efficiency. Constituents are in most water supplies.

To date, 6 inhibitors have been used in the various test periods. They are as follows:

(1) A buffered chromate compound. Marketed under the auspices of the SBI.

(2) Borate-nitrate-nitrite compound. A proprietary chemical compound distributed by a water treatment company for the express purpose of corrosion inhibition in diesel engine cooling systems.

(3) Sodium molybdate. Tested on the basis of reported work of

TABLE II

SUMMARY OF TEST CONDITIONS

Test Solution Boiler Water	Test No.	Time Tubes Immersed in Boiler Water, Hours Operating[a]	Down-Time	Type Tubes	Tube Condition	Inhibitors[g]
b	1	3307	1656	E.R.W. ASTM-A-178 Grade A Boiler Tubes	New	None
b	2	3307	1656	"	New	No inhibition initially followed by inhibitor A.
b	3	3307	1656	"	New	Inhibitor B.
b	4	3338	1625	"	New	Inhibitor A.
c	5	3148	788	"	Same as Test #1	Continued in test with addition inhibitor A.
c	6	3148	788	"	New	No inhibition initially followed by inhibitor B.
c	7	3148	788	"	New	Inhibitor B.
c	8	3148	788	"	New	Inhibitor A.
c	9	2615	865	"	New	Inhibitor C.
c	10	2615	865	"	New	Inhibitor D.
c	11	2615	865	"	Same as Test #7	Inhibitor B.
c	12	2615	865	"	New	None-Tubes painted and paint spattered.
c	13	2548	1388	E.R.W. High strength, low alloy Steel No. 1	New	None.
c	14	2548	1388	E.R.W. ASTM-A-178 Grade A	New	No inhibition, copper tankless heating coil installed.
c	15	2548	1388	"	Same as Test #7	Inhibitor B.
c	16	2548	1388	"	New	No inhibition, physico-chemical water conditioner.
c	17	2354	674	E.R.W. High strength, low alloy Steel No. 2	New	None.
d	18	2354	674	E.R.W. ASTM-A-178 Grade A Boiler Tubes	New	Inhibitor A.
d	19	2354	674	"	New	Inhibitor B.
c	20	2354	674	"	New	Inhibitor B.
c	21	2849	1351	Copper bearing steel	New	None.
e	22	2849	1351	E.R.W. ASTM-A-178 Grade A Boiler Tubes	New	Inhibitor A.
e	23	2849	1351	"	New	Inhibitors B.
c	24	2845	1351	"	New	Inhibitor E.
c	25	2338	638	"	New	Inhibitor D.
f	26	2338	638	"	New	Inhibitor A.
c	27	2338	638	"	New	Inhibitor F.
c	28	2338	638	"	New	None-Baffle Plate installed 4 in. from Flue Sheet.
f	29	2850	798	"	New	Inhibitor B.
f	30	3980	2036	"	New	Inhibitor F.
c	31	2850	798	"	New	None-Copper flash plated tubes.
f	32	2850	798	"	New	Inhibitor G.

[a] Operating time refers to actual cyclic firing of the boilers as described elsewhere. Down-time is due to inspection and routine maintenance.
[b] Boiler water No. 1 was made up from air saturated distilled water.
[c] Boiler water No. 2 was made from air saturated distilled water and contained 100 ppm chloride.
[d] Boiler water 2 + 100 ppm calcium temporary hardness plus hardness chemical additions during tests.
[e] Boiler water 2 + 100 ppm temporary hardness + 100 ppm permanent hardness plus hardness chemical additions during test.
[f] Boiler water 2 + 500 ppm permanent hardness + 1000 ppm temporary hardness initially plus hardness chemical additions during test.
[g] Inhibitor code:
(A) Buffered chromate.
(C) Sodium molybdate.
(E) "Soluble oil".
(B) Borate-nitrate-nitrite.
(D) Sodium hydroxide.
(F) Sodium borate-sodium nitrite.
(G) Sodium nitrite without buffering.

Fig. 3 Photographs of tubes after test

Fig. 3a Test 17 – 2354 hrs oxygenated-distilled water. High strength low alloy steel **No. 2. Generalized pitting corrosion (see Table III)**

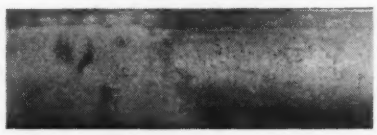


Fig. 3b Test 26 – 2238 hrs oxygenated-chloride-hardness containing boiler water (Table IV) chromate inhibitor. Only slight pitting. General tubing condition after test was good

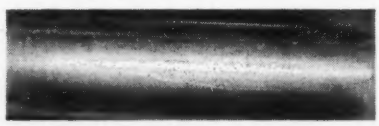


Fig. 3c Test 19 – 2354 hrs oxygenated-chloride-hardness containing boiler water (Table V). Borate-nitrate-nitrite inhibitor. No corrosion

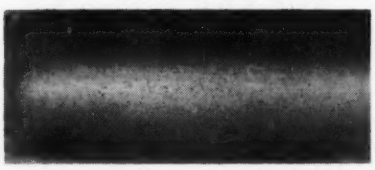
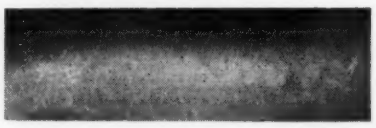


Fig. 3d Test 21 – 2849 hrs copper bearing steel tubing in chloride-oxygenated distilled water. Generalized pitting corrosion (Table III)

Fig. 3e Test 24 – 2845 hrs chloride-oxygenated-distilled water containing a "soluble oil" inhibitor. Localized corrosion (Table VI)



others,[3] reagent grade sodium molybdate meeting ACS (American Chemical Society) specifications.

(4) Sodium hydroxide. Used in two tests in a concentration sufficient to produce a pH of 11.0. Reagent grade meeting ACS specifications.

Fig. 4 Photographs after test

Fig. 4a Test 25 – 2338 hrs oxygenated-chloride-distilled water with the addition of sodium hydroxide to a pH of 11.0. Widespread corrosion (Table VI)

Fig. 4b Test 27 – 2338 hrs chloride-oxygenated-distilled water with the borate-nitrite inhibitor (Table VI) No corrosion

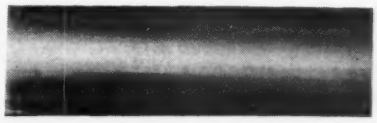


Fig. 4c Test 28 – 2338 hrs chloride-oxygenated-distilled water with baffle plate stagnation promoter installed in the boiler. Widespread rather than localized corrosion occurred (Table VII)

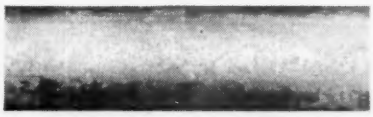


Fig. 4d Test 31 – 2850 hrs chloride-oxygenated-distilled water. Copper flash-plated carbon steel tubes. Widespread pitting corrosion (Table VII)

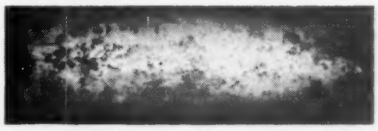
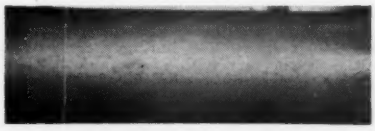


Fig. 4e Test 32 – 2850 hrs chloride-oxygenated-distilled water. Nitrite alone for inhibitor. No corrosion (Table VI)



(5) Soluble oil. A commercial grade "soluble oil" inhibitor.

(6) Sodium borate-sodium nitrite. A mixture prepared at the laboratory, the nominal concentration of the constituents was 90% sodium nitrite and 10% sodium borate.

(7) Sodium nitrite. Reagent grade made to ACS specifications.

Testing technique – Each of the tests started by making necessary mechanical changes in the boilers (see tests 24 and 28, Table VII). New tubes required by the individual test (Table II) were installed, and the boilers were given a short boil-out with 0.3 per cent sodium hydroxide solution to remove residual oil. Following the boil-out, they were drained and rinsed with zeolite treated water. After the treated water rinse each boiler was rinsed with distilled water, drained and refilled with the base boiler water. The inhibitors, hardness constituents, etc., were added to the boiler water where required.

Then the boilers were started up. An operating log was maintained for routine maintenance and records of gas pressure, cooling water pressure, boiler water level, and water analyses.

Samples of boiler water were taken twice weekly for analysis. Usual analyses consisted of pH, chloride, conductivity and inhibitor concentrations (when used). Periodically, the feedwater was analyzed for dissolved oxygen and evidences of carryover of boiler water salts to the condensate.

Each set of waterside conditions was tested for approximately six months. The test conditions and numbers are shown in Tables III through VII.

Water samples – Boiler water samples and feedwater samples were analyzed by the following methods.

pH measurements were made by electrometric techniques. Chloride analyses were made using the Mohr titration method (ASTM D-512-49).[4] Conductivity measurements were made with a L&N 4866 conductivity bridge and a glass "dip type" conductivity cell. Chromate was analyzed by the potassium-iodide-thiosulfate reaction in acid solution. Nitrate was determined by the ASTM D-992-52 method.[4] Nitrite was titrated by using a potassium permanganate-potassium iodide-sodium thiosulfate technique. Dissolved oxygen in the feedwater was measured by a modified Winkler test pattern after ASTM method D-888-49t.[4] The concentration of "soluble oil" in the boiler water was determined volumetrically with a Babcock Test Bottle using sulfuric acid to break the water-"soluble oil" emulsion.

Hardness analyses were made by means of the versenate titration. Copper in the boiler water was analyzed colorimetrically with Neo-Cuproine indicator. Borate was determined by the invert sugar-sodium hydroxide titration technique.

Corrosion measurement—A microscope calibrated for the purpose was used to measure corrosion pit depths and the number of pits per unit of metal surface were counted where possible.

Microscopic examination of

Fig. 5-A Storage container for atmospheric tests

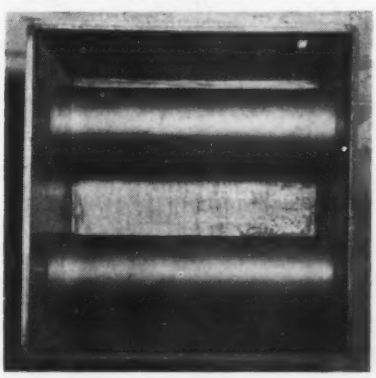


Fig. 5-B Storage container for the test under deaerated (air free) water

the tubing in place in the boilers, difficult because of the curved surface of the tubes, was accomplished by taking a clay impression of the deepest visible pits and then measuring the height of the nodule formed on the clay, microscopically. Photographic evidence was also employed for comparison between tubes.

DISCUSSION

A summary of the results of the first 16 tests follows:

1 – The buffered chromate type inhibitor is effective in halting and preventing corrosion caused by dissolved oxygen under test operating conditions. The minimum effective inhibitor concentration appears to be 2000 ppm.

2 – The borate-nitrate-nitrite inhibitor is effective in halting and preventing corrosion caused by dissolved oxygen under these test conditions. The minimum concentration appears to be 3000 ppm. At this concentration, carryover is not observed in the test equipment.

3 – Sodium molybdate and sodium hydroxide are not effective in halting dissolved oxygen attack in the test boilers.

4 – The immersion of a copper tankless heating coil in the boiler water, out of contact with the tubes, does not accelerate or localize corrosive attack under these test conditions.

5 – The physico-chemical feedwater conditioner used in this test program was ineffective in preventing or reducing corrosive attack under these test conditions.

6 – A test with high strength, low-alloy steel tubing indicated a less severe attack on it than found on carbon steel tubing under the same test conditions. Pits were shallower and the incidence of pitting was lower.

A continuation of the investigation into high strength low-alloy steel tubes was made. Test 17, Fig. 3, shows the condition of alloy No. 2 tubes after 2354 hr operation and 654 hr down-time in chloride-oxygenated distilled water. As shown in Table III, the rate of attack was somewhat less than that of plain carbon steel, but considering the depth of pitting, the difference was not significant. The test-time with this tubing was also shorter than that of the carbon steel.

Tests 18, 22, and 26 (Table IV) were designed to test further the effectiveness of the SBI buffered chromate inhibitor in the presence of hardness constituents in the boiler water. Test 26, Fig. 3, shows a representative tube. This inhibitor is effective at the nominal concentration of 2200 ppm with moderate hardness in the boiler water.

Tests 19, 20, 23, and 29 (Table V) were designed to test the effectiveness of the borate-nitrate-nitrite inhibitor at a nominal concentra-

TABLE III

SUMMARY OF THE RESULTS OF TESTS INVOLVING HIGH STRENGTH-LOW ALLOY STEEL TUBING UNDER TEST CONDITIONS SHOWN

Test No.	Material	pH Average[f]	Chloride as ppm Cl (Average)[f]	Dissolved Oxygen Concentration mls/liter (Average)[g]	Deepest Pit Measured	Number of Pits per Lineal Ft	Comments
1	Plain Carbon Steel	7.6	Not Added	5.2	0.015	3300	Generalized widespread pitting attack.
13	High strength—low alloy steel No. 1	10.0	95	5.1	0.003	615	Generalized surface brightening with slight attack.
17	High strength—low alloy steel No. 2	9.6	78	5.3	0.012	2028	Generalized pitting attack.
21	Copper bearing steel	7.7	87	4.5	0.028	2600	Generalized pitting corrosion.

[f] Boiler water [g] Feed water

TABLE IV

SUMMARY OF TEST RESULTS INVOLVING THE BUFFERED CHROMATE INHIBITOR

Test No.	Inhibitor Concentration ppm (Average)[a]	pH Average[c]	Chloride as ppm Cl (Average)[g]	Dissolved Oxygen Concentration mls/liter (Average)[h]	Deepest Pit Measured (In.)	Number of Pits per Lineal Ft	Comments
2	2116	10.5[a]	Not Added	5.4	0.010	840	Corrosion halted
4	1860	9.8	Not Added	5.3	0.010	25[c]	Slight corrosion[b]
5	1904	10.9	99	4.9	0.016	—[c]	Corrosion halted
8	2000	9.3	109	5.0	—	No Pitting	No corrosion
18	1939	11.3	78	5.3	—	—[d]	Only slight pitting attack
22	2184	10.9	79	4.5	—	—[e]	Only slight pitting attack
26	2007	10.1	85	5.6	—	—[f]	Only slight pitting attack

[a] Average pH after addition of inhibitor. Inhibitor added after corrosion was started.
[b] The slight pitting corrosion noted on the tubing in this test was attributed to an initially low chromate concentration.
[c] No increase was noted in the incidence of pitting after the addition of the proper concentration of inhibitor to the boiler water.
[d] 100 ppm calcium temporary hardness was added to the boiler water. Some slight incipient pitting was noted near the feedwater inlet. General condition of the tubes after test was good.
[e] $Ca(HCO_3)_2$, $CaSO_4$, & $MgSO_4$ was added initially at a low concentration.
[f] $Ca(HCO_3)_2$, $CaSO_4$, & $MgSO_4$ was added to the boiler water. The hardness concentration initially was very high. General condition of tubes after test was good.
[g] Boiler water.
[h] Feedwater.

tion of 3000 ppm. This inhibitor prevented the corrosion of new tubing in the presence of hardness in the boiler water. Test 19, Fig. 3, shows the tubing after tests under these conditions.

Test 21 (Tables II and III) shows the test conditions for copper bearing steel, which were comparable to those used for the other alloy steels. The results show that the corrosion resistance of this material does not differ significantly from that of plain carbon steel.

Corrosion prevention properties of "soluble oil" type inhibitors has been widely reported. These materials, strongly polar in nature, form an emulsion with water. They tend to prevent access of oxygen to the surface of metal. Therefore, when present in sufficient quantity in water, they are effective in preventing ferrous metal corrosion under various service conditions.

Test 24 (Tables II and VI) was to detect "soluble oil" in the boilers. A heavy foaming condition in the boiler water, the result of soluble oil-water emulsion at a nominal 2 per cent concentration, caused an immediate expected difficulty. In order to keep the boiler in operation and to maintain proper water level, it was necessary to install a small feed pump, controlled by the water level indicator. Oil in the gauge glass and a continuing requirement for "soluble oil" addition indicated the emulsion broke down. Fig. 3 shows the "soluble oil" inhibitor was not successful in preventing pitting attack of the boiler tubes.

Test 25 (Tables II and VI) involved further work on sodium hydroxide in the boiler water with new tubing. The previous tests

TABLE V

SUMMARY OF TEST RESULTS INVOLVING THE BORATE-NITRATE-NITRITE INHIBITOR

Test No.	Inhibitor Concentration ppm (Average)[j]	pH Average[j]	Chloride as ppm Cl (Average)[j]	Dissolved Oxygen Concentration mls/liter (Average)[k]	Deepest Pit Measured (In.)	Number of Pits per Lineal Ft	Comments
2	7281	9.1	Not Added	—[a]	No pitting	—	No corrosion
6	7183	9.5[b]	100	5.1[a, c]	0.008	—[d]	Corrosion halted
7	6318	9.1	99	—[a]	No pitting	—	No corrosion
11	4000	9.1	92	—[a]	No pitting	—	No corrosion
15	2500	9.2	97	5.5[c]	No pitting	—	No corrosion
19	2694	9.4	119	5.5	No pitting	—	No corrosion[f]
20	2756	9.4	143	5.5	No pitting	—	No corrosion[g]
23	3214	9.4	86	4.6	No pitting	—	Slightly roughened tube surface[h]
29	3232	9.2	96	5.9	No pitting	—	No corrosion[i]

[a] Excessive carry-over experienced with the borate-nitrate-nitrite inhibitor at this concentration prevented the chemical determination of dissolved oxygen in the feedwater.
[b] Average pH value after the addition of the inhibitor. Corrosion was started in uninhibited boiler water.
[c] Dissolved oxygen concentration prior to addition of the inhibitor.
[d] Compared photographically with earlier inspections prior to inhibitor addition.
[e] Carryover was insignificant below the 3000 ppm concentration under these test conditions.
[f] Initially 100 ppm calcium temporary hardness ($Ca(HCO_3)_2$) was added to the boiler. Additional $Ca(HCO_3)_2$ was added during the test period.
[g] Test made with new tubing. Test numbers 7, 11, and 15 were made without replacing tubing.
[h] 100 ppm of both permanent and temporary hardness was added to the boiler water initially. Additional hardness was added during test.
[i] 1000 ppm temporary harness was added to boiler water initially along with permanent hardness. Hardness additions were made during the test.
[j] Boiler water.
[k] Feedwater.

TABLE VI

SUMMARY OF TEST RESULTS INVOLVING THE SODIUM HYDROXIDE, SOLUBLE OIL, SODIUM MOLYBDATE, SODIUM BORATE-SODIUM NITRITE AND SODIUM NITRITE

Inhibitor	Test No.	Inhibitor Concentration ppm (Average)[g]	pH[g]	Chloride as ppm Cl (Average)[g]	Dissolved Oxygen Concentration mls/liter[h]	Deepest Pit Measured	No. of Pits per Lineal ft of tubing	Comments
Sodium molybdate	9	1978	10.5[a]	98	4.5	0.005	—	Some inhibition of continued corrosion
Sodium hydroxide	10	—[b]	11.0[a]	90	4.7	0.014	—[c]	No inhibition of further corrosion
Sodium hydroxide	25	—[b]	11.0[d]	90	4.7	—	—	General corrosion
Soluble oil	24	1.4% (by volume)	8.4	93	3.9[e]	—	—	Localized corrosion where film broke down
Sodium borate—Sodium nitrite	27	$Na_2B_4O_7$ 276 $NaNO_2$ 2079	9.7	76	5.1	—	—	No corrosion
Sodium borate—Sodium nitrite	30	$Na_2B_4O_7$ 2030[f] $NaNO_2$ 332	9.6	90	5.1	—	—	No corrosion
Sodium nitrite	32	2276	9.9	100	6.1	—	—	No corrosion

[a] Average pH value after addition of the respective inhibitors. Corrosion initiated in chloride-oxygenated distilled water.
[b] The addition rate of sodium hydroxide was controlled by boiler water pH.
[c] Deep pits occurred which were overlayed by large carbuncles.
[d] Sodium hydroxide was added at start of test with new tubing in this case.
[e] Carryover of soluble oil into condensate resulted in erratic dissolved oxygen determination. Serious foaming occurred in boiler water.
[f] A high level of temporary ($Ca(HCO_3)_2$) hardness and permanent ($CaSO_4$, $MgSO_4$) was added after 1650 hrs of operation.
[g] Boiler water.
[h] Feedwater.

Fig. 6 Corrosion by dissolved oxygen

Fig. 6a Post test condition of tube stored in distilled water containing chloride and open to the atmosphere (2713 hrs) Test 1 (Table IX)

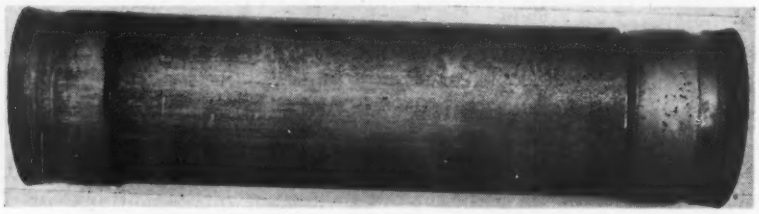
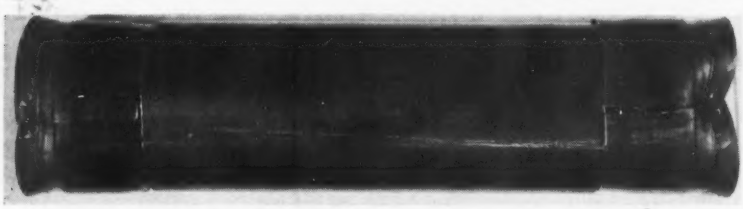


Fig. 6b Post test condition of tube stored in deaerated distilled water containing chloride for 2713 hrs. Test 2 (Table IX)



with sodium hydroxide, on tubing, already corroded under uninhibited conditions was done to see if sodium hydroxide would stop corrosion. At a pH of 11.0, it was again ineffective, even with new tubing (Fig. 4). Sodium hydroxide can only reduce the rate of corrosion.

Tests 27 and 30 (Tables II and VI) involved the use of a sodium nitrite-sodium borate mixture. The nominal concentration of sodium nitrite was 2250 ppm; the nominal sodium borate concentration 250 ppm. Test 27, Fig. 4, shows the result. The inhibitor mixture was effective in preventing corrosion in chloride-oxygenated test water, both with and without adding a moderate concentration of hardness constituents to the water.

During the course of these investigations, considerable interest was directed toward the deep "isolated pit" type corrosion. In all tests, a generalized wide-spread pitting type corrosion occurred. A consensus grew that one cause of this serious localized corrosion, which had been observed in the field, might be localized stagnant areas in the boiler.

A mechanical change in one test boiler (Test 28) included a baffle plate 4½-in. from the flue sheet. A 1/16-in. clearance was provided between the baffle and the tubes and several ¾-in. drain holes were drilled in the baffle plate to facilitate filling, draining and to provide for boiler water-level equalization. The boiler water was chloride-oxygenated distilled water. No localization of corrosion occurred.

This corrosion, shown in Test 28 (Fig. 4), was the wide-spread pitting type. Test conditions are tabulated in Tables II and VII. If structural peculiarities in the boiler contribute to localized tube corrosion, the mechanical changes made here did not provide adequate simulation of these effects.

Frequently, tubing from operating boilers has revealed considerable metallic copper in the water-side deposits. This copper originates from corrosion of condensate return piping and is carried into the boiler with the feedwater.

Fig. 7 Localized corroded areas on tube removed from chloride containing distilled water after 2328 hrs. Water was inhibited with 2000 ppm SBI chromate. Carbuncles have been removed

Test 31 was on copper flash-plated (acidic copper sulfate) tubes to observe what effect they might have on corrosion. These tubes were installed in one test boiler and operated for 2850 hrs during which 798 hrs of down-time occurred (Tables II and VII). Results showed no significant increase in corrosion as a result of copper deposition.

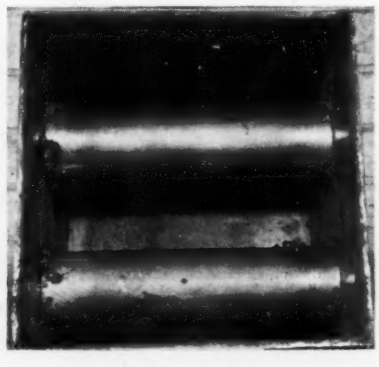
Test 32 involved the use of only sodium nitrite as an inhibitor in chloride-oxygenated-distilled water. No corrosion occurred during this test (Fig. 4, Tables II and VI). Note, however, that the average pH was 9.9 and the lowest pH recorded was 8.7. If the pH had fallen below 7, the inhibitor would not have been effective. Sodium borate is normally added to this inhibitor to insure maintenance of an alkaline pH. Therefore, inclusion of sodium borate in the sodium nitrite inhibitor formulations is recommended.

WET STORAGE TESTS

During the accelerated tube corrosion test program, there was considerable discussion of summer storage periods of boilers. It was felt that many of the tube corrosion difficulties begin at that time. Tests were designed to study tube corrosion during boiler storage periods.

Test Equipment—Small steel boxes were constructed from ¼-in. carbon steel plate (Fig. 5). One box was designed so that deaeration could be carried out, and the water-

Fig. 8 Large carbuncles on tubes and tube sheets in a chloride containing (140 ppm) Chromate treated (2000 ppm). Storage test within 48 hrs. Test 13 (Table IV)



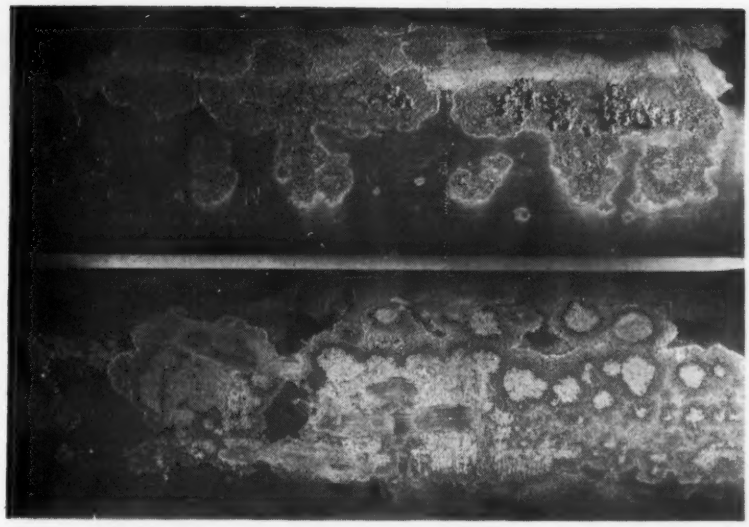


Fig. 9 Severe corrosion on tubes stored in sulfate containing (705 ppm) Borate-Nitrate treated (2510 ppm). Test 18 (Table IV)

sides were blanketed and sealed under nitrogen (Fig. 5). A sealed glass plate was provided for test observation.

Two sides of the carbon steel boxes served as tube sheets so that tubes could be "rolled in" simulating the mechanics of boiler construction.

Boiler tubes – Electric resistance welded tubes made to ASTM-A-178 Grade A specifications were used in these tests. Typical tube metal analyses for these tests are shown in Table VIII.

Testing technique—The inside surfaces of the test boxes were carefully cleaned and sections of new tubing were rolled into the simulated tube sheets. All surfaces in contact with water were then cleaned with trichloroethylene, rinsed with distilled water and dried with methyl alcohol.

Test boxes were filled with distilled water; sodium chloride and sodium sulfate were added as an electrolyte, depending on proposed test conditions, as was the proper chemical inhibitor.

They were stored at room temperature for periods of one to three months. A visual inspection was made each day to observe the presence or absence of corrosion. The water in the test boxes was analyzed at the beginning and at the end of each test, by methods described in section one. The extent of corrosion was recorded photographically.

DISCUSSION

Fig. 6 shows a comparison between tubes immersed in chloride-containing water under atmospheric and deaerated (air boiled out-layed up under nitrogen seal) conditions. Table IX shows the initial and post test analysis of the water from each test. The effect of oxygen dissolved from the atmosphere above the test water is readily apparent in the widespread pitting attack on the tubes of the box open to air. No preferential corrosion locations were noted on the tubing. The corrosion rate lessened in time, due to the formation of a film of hydrated iron oxide on the surface of the water which restricted oxygen access to the water. Further proof was the high concentration of ferrous iron in the water after the test. This iron oxidized and precipitated when exposed to air.

After demonstrating the effect of dissolved oxygen on steel in this manner, researchers tested, under storage conditions, the efficiency of the inhibitors which had shown promise.

New tubing was installed in the test boxes, and after cleaning, new chloride-containing test solutions were added. SBI chromate at a concentration of 2000 ppm was added to the water in one test box while 3000 ppm of the pro-

(Continued on page 104)

TABLE VII

SUMMARY OF TEST RESULTS INVOLVING THE EFFECT OF MECHANICAL CHANGES ON TUBE COMPOSITION

Test No.	Conditions	pH Average	Chloride as ppm Cl (Average)	Dissolved Oxygen Concentration mls/liter (Average)	Deepest Pit Measured	Number of Pits per Lineal Ft	Comments
12	Paint spattered tubes	7.6	102	4.8	Etched appearance	—	Corrosion accelerated locally.
14	Copper heating coil immersed in boiler water.	10.4	89	5.3	0.011	2770	Did not appear to localize or accelerate corrosion.
16	Physico-chemico water conditioning device.	10.1	94	4.8	0.020	2940	The device did not decrease corrosion.
28	Baffle plate installed adjacent to flue sheet.	10.5	88	5.1	0.016	1272	No localization of corrosion.
31	Tubes flash plated with copper.	9.0	93	6.0	0.018	3423	No definite acceleration of corrosion could be established.

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They Wanted to Know

Inquiries of the month to ASHRAE Headquarters covered many points as to technical facts, standards, practices, personnel and published references. From these, the following have been selected and condensed as being those replies of some general interest and value to ASHRAE members.

MOISTURE TEST FOR REFRIGERATION TUBING

To ASHRAE:

Have there been any recent revisions in the method of test for moisture in refrigeration tubing?

J. F. E.

ASRE in 1940 had a circular concerning water content limits for refrigerating system parts. This circular indicated that the maximum permissible water content of refrigerant system tubing or cooling coils as received at the point of installation should be 10.6 milligrams per liter of internal volume of the tubing or coil. This procedure, however, was discontinued by action of ASRE Council in 1952 and removed from our list of publications. We deleted this test because it was believed that manufacturers of tubing for refrigeration purposes provided sufficiently dry tubing as a result of their normal manufacturing procedures. ASTM standard specification for seamless copper tube for refrigeration field service states that "Tube supplied under this specification shall be dehydrated and sealed at both ends of each coil." Copy of this specification may be obtained from ASTM headquarters.

LIMIT SWITCH FOR WARM AIR BONNET OF FURNACE

To ASHRAE:

We are interested in authoritative information from standards on practices for setting the temperature limit control switch on warm air bonnets of forced warm air furnaces. Especially, for the switch which shuts off supply fuel when failure of blower or reduced air flow due to clogged filter causes overheating.

C. B. R.

Our publication, the ASHRAE Heating, Ventilating and Air Conditioning GUIDE, Chapter 18, Warm Air Heating Systems, has this to say concerning automatic controls: "A high limit control, also in the bonnet of the furnace, to stop the burner independently of the room thermostat if the air temperature exceeds 200 F, the Fan thermostat and high limit control are sometimes combined into a single unit." The American Standard on this subject was developed by the American Gas Association, 420 Lexington Ave., New York 17, N. Y., for gas-operated systems. The National Warm Air Heating & Air Conditioning Association, 640 Engineers Building, Cleveland 14, Ohio, and the Underwriters' Laboratories, Inc., 207 East Ohio Street, Chicago 11, Ill. may also have standards referring to this subject.

LIVER OIL BY FREEZING

To ASHRAE:

We have received an inquiry concerning the production of liver oil by freezing. Any information you might have on the subject would be appreciated.

M. S.

It has been determined that the freezing system of extracting oil from fish livers is not used in this country. All such vitamins are made synthetically. A publication titled "Progress in the Chemistry of Fats and Other Limpids" by Holman, Lundberg and Malkin, 1958 and published by Pergammon Press, contains a chapter related to this subject.

WAGE SCALE FOR U.S. ENGINEERS

To ASHRAE:

Can you give me an idea of the wage scale for design engineers in the heating and air-conditioning engineering fields in the United States?

J. M.
London, England

There are so many variables that a definite answer is impossible. However, a report by the Engineers and Scientists of America in 1958 gives the minimum starting salaries for engineers. Number of years and "quality" of experience after receiving a BS degree are taken into account. Assuming one is in the 70% quality percentile group, an engineer could expect a salary of $525 per month without experience, $655 a month after working 5 years, and $810 per month after ten years experience in American engineering procedure. The report is available at the Engineers and Scientists of America, 343 Muncie Building, Washington 4, D. C.

CHAPTER NEWS RESUMES NEXT MONTH

Customarily omitted during the summer months when activities minimize, the Chapter News spreads in the JOURNAL will be resumed in our November issue.

There are 88 ASHRAE Chapters, each one of which may report happenings of more than local interest each month.

The Editors welcome news of Chapter meetings. In fact, their goal is a usable monthly report upon each one. They do ask that such news be written to emphasize specific facts discussed or presented, that time values be observed and that significance be the guide to inclusions or omissions in submitted reports.

South Piedmont Chapter Exceeds Its UEC Quota

North Carolina chapter is second to achieve and exceed quota

A well-organized, hard-hitting, personal-contact campaign is a tried and true method of raising funds . . . and when there is no balance in the treasury . . . the ONLY way. However, the 87 members of the South Piedmont Chapter in North Carolina are enthusiastic meeting-attending dues payers . . . and there was a balance in the treasury.

The South Piedmont Chapter is using money from its dues to meet its quota in the ASHRAE-UEC Fund Raising Campaign. Based on the premise of $15 per member, the quota was $1,305. Pledged is $1,500.00, to be paid over a three-year period.

South Piedmont now becomes the second chapter, not only to reach, but to exceed its quota. Earlier this year, the 116-member Central Oklahoma Chapter pledged $2,082.50. (ASHRAE JOURNAL, June 1960, page 59).

Here is how Neal McGuire, past president of the South Piedmont Chapter, outlines his Chapter's progress in achieving its quota.

"Last fall, we received the publications and initial letters from your headquarters pertaining to the UEC Fund Raising Campaign. At that time, as president of this Chapter, I appointed a committee to study this matter. This committee and our Board of Governors made recommendations to the Chapter members and, finally, at our May meeting a motion was made which received the unanimous vote of our members. As you are now aware, the Chapter voted to contribute $500 each year for the next three years, or a total of $1,500, to the UEC Fund. The initial $500 contribution was forwarded several months ago.

"After due consideration, the special committee and Board of Governors recommended to our members that we use, for our initial donation, part of the balance in our treasury. This balance had been acquired over the years in our collection of local dues. It is also our Chapter's plan to continue to collect local dues over a period of the next several years, and it was deemed desirable to use these dues for our contribution to UEC rather than ask each member to make any additional, or other, donation. Our members felt that along with the funds which we receive each year from the National Chapter, these local dues would enable us to meet our pledge to the UEC Fund, as well as to support some of the lesser activities of our Chapter, such as our monthly meeting notices and associated cost of operating the Chapter.

"Our members are proud to have been able to contribute to the Campaign and take part in this worthwhile project."

CONGRATULATIONS TO THE SOUTH PIEDMONT CHAPTER! BUT THERE ARE 86 CHAPTERS YET TO ACHIEVE THEIR QUOTAS. DO NOT SLACKEN YOUR EFFORTS BEFORE WE ANNOUNCE THAT THE $250,000 QUOTA IS PASSED. THE ASHRAE CAMPAIGN WILL CONTINUE UNTIL THAT GOAL IS REACHED. WE HAVE $223,629 TO GO!

NAME .....

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IN CONSIDERATION OF THE GIFTS OF OTHERS INTENDS TO GIVE TO

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MEMBER ASHRAE

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29 WEST 39TH STREET, NEW YORK 18, N. Y.
GIFTS ARE DEDUCTIBLE FOR INCOME TAX PURPOSES

For your convenience a contribution pledge form is incorporated within this page. Mail to ASHRAE, 234 Fifth Avenue, New York 1, N. Y.

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PARTS and PRODUCTS

GAUGELESS REGULATORS

Two-stage gas pressure regulators without conventional glass-covered gauges are being marketed by this company. Available for both oxygen and acetylene cylinder use in welding, heating or cutting operations, gaugeless regulators are particularly useful where extremely rough service is encountered.

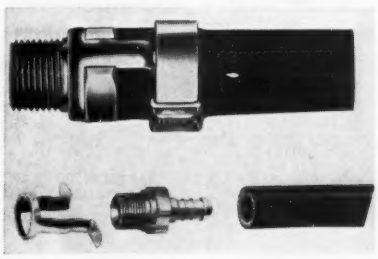
Delivery pressure is set with a micrometer type indicator. Two ranges of regulation are available by means of a low-high marking on the adjusting knob, and three lines on the spring case. Regulators are also equipped with a cylinder pressure indicator clearly visible at the top of the unit and protected from damage by a forged brass housing.

Available are an oxygen regulator with max work pressure of 100 psi and two acetylene regulators with max work pressure of 15 psi.

Air Reduction Sales Company Div, Air Reduction Company, Inc., 150 E. 42nd St., New York 17, N. Y.

HOSE COUPLING

Five available sizes (¼, ⅜, ½, ¾ and 1 in. ID) of this hose coupling assembly are cited as fitting any hose OD or wall thickness. Designated Piggyback Tri-Lokt hose nipple assembly, it may be used for hydraulic hose, double and single braid; steam hose; and all types of hose which



require a positive lock to the hose nipple. All-purpose and re-usable, it utilizes a specially designed stem to minimize abrasion within the hose and locks in three places in addition to the clamp and nipple methods now in use.

Comprising the assembly are a hose nipple and yoke, with the yoke locked by two stainless steel clamps, one placed on top of the other. In addition, the nipple is held permanently in place by the yoke tie-ends and at the third locking point by the anchoring force of the yoke upon the nipple. When used with wire braid hose, the assembly is applied directly to the hose with no further preparation than cutting the end of the hose. Hose cover is not removed, nor is the inside diam trimmed.

Band-It Company, 4777 Dahlia St., Denver 16, Colo.

VARIABLE SPEED DRIVE

Speed ranges from 1.2 to 4660 rpm with up to ten-to-one variation are offered in ¼, ½ and ¾-hp ratings for Speed-Trol motors. Larger pulley diam assures a cooler running, longer lasting belt. Retention of Nema standard dimensions for shaft height and diam permit substitution with standard motors. Electrical characteristics and enclosures include single and three-phase, drip-proof, totally enclosed and explosion-proof. New unit may be foot mounted in any position or can be furnished with face mounting bracket. It is available with right angle and helical gears.

Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles 22, Calif.

CONTROL AND SWITCH

To provide dependable liquid level control in most locations where vibration and corrosion are serious problems, this company has developed Model 752 (shown), a single-stage, external float cage style control. This addition to the manufacturer's line of controls can be operated either electrically or pneumatically. Anti-corrosive features of the unit are float balls of Type 316 stainless steel, attraction sleeve sheathed with Type 304 stainless steel and Type 304 stainless steel trim furnished as standard. Twelve float chambers are available to meet most pressure-temperature-specific gravity conditions. Unit is equipped with an explosion-proof/vapor-proof switch housing and operates with approximately ¾-in. liquid level travel between switch actuation levels.

Designed especially for Model 752 is a new electric switch mechanism, designated S-6. It is a magnet-actuated, two-position, snap-action mercury switch with anti-vibratory features. All metal parts are of aluminum and stainless steel, including terminal board inserts, binding screws and eyelet connections on mercury switch lead wires. It can be furnished with single-pole or double-pole mercury switch actions. Standard mercury switches are available to close up to four circuits to common or for double-pole, double-throw action. Mechanism can be furnished in a standard (splash-proof) housing or an explosion or vapor-proof housing. Switches are rated four amp at 115 volt ac, two amp at 230 volt ac and one amp at 440 volt ac. Max temperature is 450 F.

Magnetrol, Inc., 2110 S. Marshall Blvd., Chicago 23, Ill.

PORTABLE OSCILLOGRAPH

Recommended for application in utilities and research laboratories, the Type 5-124 portable industrial oscillograph may also be utilized for hospital, weather station and telemetry ground station applications. Record speeds of 0.25, 1.0, 4.0, 16.0 and 64.0 in./sec are provided by a five-speed pushbutton controlled trans-

mission. Any speed may be selected while the motor is running, without interrupting the recording operation. Recording is by the print-out process and the unit has a 200-ft record capacity of seven-in. paper.

Front access for loading, operating and data viewing makes the unit suitable for rack-mounted installations. Completely electrically-isolated three-conductor connectors, incorporating snap-in, crimp-type contacts, are provided for each galvanometer input to enhance flexibility. Damping resistor shells compatible with the galvanometer input connectors are available. Writing speeds up to 50,000 ips/sec are attainable, with timing accomplished by either a flash tube or timing galvanometers. Other features in-

(*Continued on page* 83)

New Air Filter Test

A. T. BOGGS, III
ASHRAE Technical Secretary

The **Air Filter Institute** recently announced adoption of a new test for high efficiency air filter units. The new test augments the gravimetric procedure used with panel-type filters. The gravimetric test which is similar to the Bureau of Standards dust-spot method uses artificial dust. The new AFI test uses atmospheric air drawn through filter papers located upstream and downstream from the cleaner being tested. After exposure for a set time, the two samples of filter paper are photometrically compared for differences in light transmission. E. F. Snyder, AFI president, states that the new tests will give a far more accurate performance index for filters in the 50-90 per cent efficiency range. The new AFI code details critical items in dimensions and test procedures so that results from different laboratories can be compared directly. Copies of the new AFI code may be obtained from the Air Filter Institute, P. O. Box 85, Station E, Louisville 8, Ky.

AMCA: Bulletin 210, Standard Test Code for Air Moving Devices, was approved by AMCA membership May 25, 1960. The 1960 edition is the fifth in a series that started in 1923. Bulletin 210 supersedes Bulletin 110. Based on research, various engineering improvements have been made and a nozzle test added to the code. Because of the increase in high-pressure applications, provision has been made in the code for the effect of compressibility. The purpose of Bulletin 210 is to establish uniform methods for conducting tests on air-moving devices to determine flow rate, pressure, power, speed of rotation, and efficiency. Copies are available from Air Moving & Conditioning Association, 2159 Guardian Bldg., Detroit 26, Mich.

ASA: Uniformity in the use of the decimal in. is the primary objective of a new standards project established by the Mechanical Standards Board of ASA. The scope of the project is to define the decimal in. and its present preferred systems and interpretation for its application in various types of industries. ASTM proposed this project and will be the sponsor. Development of a practical and methodical system of using decimals of the in. that would be acceptable to a consensus of industry will be a principal step toward **standardized measurements.**

ASTM: A new tentative specification for **structural steel (ASTM A 36-60 T)** has been approved by ASTM and the new structural steel is now a stock item for steel mills and warehouses throughout the country. The guaranteed minimum yield point of A 36 steel is 36,000 psi. The increased cost is relatively less than the increased yield point obtained so that economy will result in its use. Copies of the tentative specification may be obtained from ASTM, 1916 Race Street, Philadelphia 3, Pa.

Govt.: The Bureau of Standards has announced availability of a **directory of standardization activities** in the U. S. Copies are available at $1.75 each from the U. S. Government Printing Office, Washington 25, D. C. This new directory provides a descriptive inventory of the work and objectives of organizations involved in standardization activities. Each organization is listed alphabetically with a brief description of its standardization objectives and accomplishments.

Commercial standards issued by the Department of Commerce now include a new policy concerning publication of grade trademarks and other product identifications. The new policy will eliminate from published Commercial Standards any reference to trade associations, industrial firms, or other organizations in the identifying marks used to designate products covered by or complying with such standards. The purpose of this change is to avoid any implication of endorsement by the Department of Commerce of any particular producer or private organization.

A new Commercial Standard for Copper Drainage Tube is available from the Superintendent of Documents at 10c each. This standard is designated **CS229-60, Copper Drainage Tube (DWV).** The standard became effective for new production on June 1, 1960. Requirements are included for chemical composition and mechanical properties of the tube including the dimensions, tolerances, and weights for nominal sizes ranging from 1¼ to 8 in.

WHO'S WHO IN ASHRAE

Insofar as possible, these listings will each appear twice a year

ASHRAE OFFICERS, DIRECTORS, COMMITTEES, STAFF
See page 78, this issue

REGION AND CHAPTER OFFICERS
See page 90, May JOURNAL

RESEARCH AND TECHNICAL COMMITTEES
See page 67, September JOURNAL

STANDARDS PROJECTS
See page 63, July JOURNAL

INTER SOCIETY COMMITTEES
See page 66, February JOURNAL

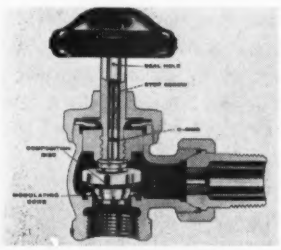
PARTS AND PRODUCTS

(*Continued from page* 81)

clude an automatically regulated galvanometer lamp circuit, unexposed footage indicator, high intensity mercury vapor light source and intensity control and a choice of 6, 12 or 18-channel magnet block. Unit operates on a power source of 105-125 volt, 50/60 cps, 500 watt max.
Electro Mechanical Instrument Div, Consolidated Electrodynamics Corporation, 360 Sierra Madre Villa, Pasadena, Calif.

RADIATOR VALVE

Adjustable orifice on this new series of packless radiator valves permits accurate balancing of steam or hot water. Required orifice adjustments may be made without shutting down the system or disturbing connections simply by removing a screw in the



valve handle and inserting a screw driver in the hollow valve stem until it engages the stop-screw. This screw is then adjusted to limit the valve opening to any required rate of flow: on steam, from ten to 100 sq ft E.D.R.; on hot water, any flow rate at any pressure. Since the adjustment merely limits the opening, shut-off is always positive at any setting without disturbing orifice adjustment. Series R-105 is available in ½, ¾ and 1-in. sizes; angle, straightway and corner patterns.
Marsh Instrument Company Div, Colorado Oil & Gas Corporation, Skokie, Ill.

IMPULSE STEAM TRAP

Designated No. 130 impulse steam trap, this component for steam lines consists of a trap with strainer and blowdown valve combined in one body. Designed for light condensate loads with steam pressures from 8 to 600 psi, the unit requires only two connections. Utilized is a thermodynamic principle of steam trapping in which the valve disc snaps open to discharge condensate but closes on steam. It operates against back pressures up to 50% of steam line pressure and is furnished with ½-in. pipe connections.

Placed ahead of the strainer screen and trap, the blowdown valve, which may be opened and closed by an Allen wrench, has a threaded outlet for applications where it may be desirable to pipe blow-off away from the immediate area.
Yarnall-Waring Company, Philadelphia, Pa.

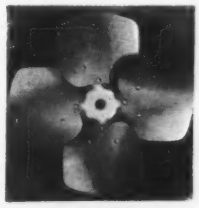
T-FITTING

Providing the benefits of a single-piece installation, this four-seal T-fitting eliminates the need for adapters, connectors and special fittings when applying pressure gauges or other instruments to hydraulic, pneumatic and process lines. Four positive seals against pressure, temperature, vibration and surge are embodied, plus a vibration dampener. Unit is offered in sizes from 1/16 through two-in. diam, with pipe thread.

C. B. Crawford Company, 16606 Waterloo Rd., Cleveland 10, Ohio.

AXIAL FANS

Series N axial fans have been designed for efficient, high-output operation over an extensive range of both free-air and pressure applications. Performance is cited as being equal to the company's E, P and S models, and as a standardized design, the line will ultimately replace all three types in new air moving equipment.



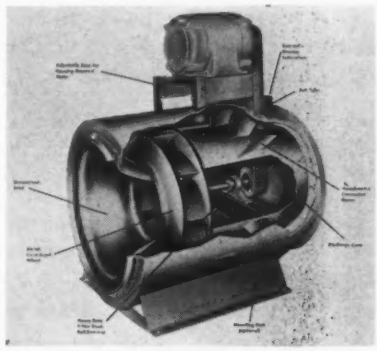
Fans in the new series are now available in diam of 8, 10, 12, 14, 16, 18 and 20 in. Improved blade design allows an N fan of the same diam but smaller axial depth (lower pitch angle) to deliver about the same air output as any of the three other types. Typical applications of the units include unit heaters, air conditioners, window fans, evaporative coolers, small remote air conditioners and space heaters.
Air Impeller Div, Torrington Manufacturing Company, Torrington, Conn.

ENCAPSULATED MOTORS

"Howellsealed" encapsulated motors – three or two-phase, one through 125-hp ac squirrel cage – provide open-motor performance for applications usually requiring enclosed motors because of exposure to excessive heat, moisture, acids, gases, salts, alkalis, caustics, fine abrasives, shock or vibration. "Howellseal," according to the manufacturer, is a specially developed epoxy compound, applied under vacuum to surround each wire in slots and at coil ends, producing a solid, void-free mass. Motors are available in Nema designs A, B, C and D for one, two, three or four-speed constant or variable torque operation at all standard voltages and frequencies.
Howell Electric Motors Company, 16316 W. Seven Mile Rd., Detroit 35, Mich.

CENTRIFUGAL FAN

Introduction of a new straight-line flow centrifugal fan, shown in a cutaway illustration, is cited as making possible air conditioning and air handling fan installations in less than half the space required previously. Designated Centriline, the new unit combines advantages of airfoil-bladed centrifugal fan performance with space-saving features of straight-line air flow. While the exterior shape of the unit resembles that of an axial fan, it is actually of the centrifugal type, utilizing an airfoil-bladed centrifugal wheel which enables air to follow the blade contours closely and prevent noise-producing turbulence on upper blade surfaces. Aerodynamic conversion vanes also work to minimize noise.



Centriline fans are available in six sizes, with airfoil wheels from 27 to 44½ in. diam, all of unobstructed design with no intermediate rings or stay rods to interfere with air flow. Two methods of mounting are allowed for: with motor base on the fan housing and with motor mounted separately on an integral vibration base. Both arrangements are V-belt driven. Volumes range from 4700 to 46,800 cfm and pressures up to nine in. of water static.
Westinghouse Electric Corporation, Sturtevant Div, Hyde Park, Boston 36, Mass.

Meetings ahead

October 10-12 – American Gas Association, Annual Convention, Atlantic City, N. J.

October 20-23–Refrigeration Service Engineers Society, Annual Convention, Portland, Ore.

October 25-27 – American Standards Association, 11th National Conference on Standards, New York, N.Y.

October 28-November 2 – Air Conditioning and Refrigeration Wholesalers, Silver Anniversary Convention, SS Hanseatic.

October 29-November 4–Oil Heat Institute, Diamond Jubilee Cruise and Management Conference, HMS Queen of Bermuda.

October 31-November 3 – Institute of Boiler and Radiator Manufacturers, Semiannual Meeting, Absecon, N.J.

November 14-16–National Warm Air Heating and Air Conditioning Association, 47th Annual Meeting, Cleveland, Ohio.

November 15-17 – Building Research Institute, Fall Conferences, Washington, D. C.

November 18-22 – Air Conditioning and Refrigeration Institute, Annual Meeting, Hollywood Beach, Fla.

November 20-23 – Refrigeration and Air Conditioning Contractors Association, Annual Meeting, Miami, Fla.

November 27-December 2–American Society of Mechanical Engineers, Annual Meeting, New York, N. Y.

November 28-December 2–24th National Exposition of Power and Mechanical Engineering, New York, N. Y.

December 1-2 – National Association of Practical Refrigerating Engineers, Annual Meeting, St. Louis, Mo.

December 12-15–Industrial Building Exposition and Conference, New York, N. Y.

February 13-16–American Society of Heating, Refrigerating and Air Conditioning Engineers, Semiannual Meeting, Chicago, Ill.

February 13-16 – 15th International Heating and Air-Conditioning Exposition, Chicago, Ill.

People

Rolland S. Stover, nominated to serve as a Director of the American Society of Mechanical Engineers, is owner of R. S. Stover Company, Secretary-Treasurer of Iowa Pipe & Supply Company and Treasurer, Contractors, Inc. Since graduation from the University of Kansas in 1933, he has participated in pioneering steps in oil production and has served with Gypsy Oil Company, Smith Separator Corporation and Fisher Governor Company. He organized his own company, which serves as a manufacturers' representative, in 1943. In the former ASHAE, he has held all offices in Iowa Chapter, was President in 1950-51 and Chairman of the national Chapter Conference Committee in 1955. A member of ASME since 1948, he has served in all offices of the Central Iowa Sect, being Chairman in 1951-52, and was Chairman of the national Nominating Committee in 1954-55. As Vice President, Region VI, he was a member of Council (1956-58) and is presently ASME representative to Engineers' Joint Council. He has been active in work of the Iowa Engineering Society since he became a member in 1948. He received the Anson Marston Award in 1951, was Treasurer of the Iowa Engineering Society in 1952-53, President-Elect in 1954-55 and President in 1955-56.

Joseph V. Weigle advances to the newly created position of Field Sales Manager for the Applied Machinery and Systems Dept of Chrysler Corporation's Airtemp Div from his previous position as Manager of Contract and Order Administration. With Chrysler since 1952, he began as a field engineer in the New York office, moved in 1953 to Philadelphia as Senior Engineer and to Dayton in 1957, where he was Zone Manager, Product Manager and Manager of Contract and Order Administration. He is an alumnus of Newark College of Engineering, with a B.S. in electrical engineering.

James Wheeler of the Houston office of American Radiator & Standard Sanitary Corporation's Industrial Div has been transferred to Detroit as National Manager of air conditioning products. **Thomas Rollings** of the same organization has been appointed Branch Manager of the Houston office.

Harold Martin Hendrickson, 58, ASHRAE Fellow and Professor of Mechanical Engineering at the University of Washington, died August 8th of a rare nerve ailment. Born in Superior, Wisc., he attended local Seattle schools and the University of Washington, where he received the degrees of B.S. and M.E in mechanical engineering. Well known in the field of refrigeration and air conditioning prior to joining the faculty of the University as an associate professor in 1949, he had worked for several Seattle firms and for Carrier and York Corporations, Safeway Stores and Ralph E. Manns Company. He was elevated to full professor in 1955. Chairman of Puget Sound Chapter, ASHRAE, he had served as Chairman of Pacific Northwest Sect, ASRE, in 1954-55 and President of Southern California Chapter, ASHAE, in 1938-39. He was a Director and Member of Council, ASRE, 1955-58, and Editor-in-Chief of the Data Book in 1954-55. A consultant on refrigeration and air conditioning for industry and the University Hospital, he was co-supervisor for research on desalting of sea water and contributed a number of articles to technical publications.

Charles S. Stock has been appointed to the post of Manager of Central Marketing of American Air Filter Company, and will be responsible for formulation, development and coordination of the over-all policies, objectives and programs for marketing the company's products. Succeeding him as Manager of the School Air Systems Div is **Frank K. Platt,** formerly Assistant to the Manager. At the same time, **A. B. Ullrich, Jr.,** has been named Manager of Engineered Air Systems Div, which markets industrial and commercial heating, ventilating and air conditioning products.

Burgess H. Jennings is returning to Northwestern University this fall to resume his position as Professor of Mechanical Engineering, an appointment he relinquished three years ago to become Director of Research at the ASHRAE Laboratory in Cleveland. He will remain part-time Director of the Laboratory. ASHRAE Fellow and past-President of the former ASRE (1949), Professor Jennings has served the Society on many committees. A member of the former ASHAE since 1942, he has been a member of the Guide Publication Committee (Chairman, 1952), several Technical Advisory Committees, Research Executive Committee, Research Long-Range Planning Committee and Committee on Research (Chairman). He holds the degrees of Bachelor of Engineering, Johns Hopkins University, 1925; M.S., Lehigh University, 1928; and M.A., Lehigh University, 1935. An active consultant from early in his professional career, he includes among his clients Philadelphia & Reading Coal & Iron Company, Frigidaire Div of General Motors, Dole Refrigerating Company, Argonne National Laboratory, Office of Naval Research and Rock Island Arsenal. Actively engaged in education for more than 30 years, he served on the staff of Lehigh University from 1926 to 1940, when he was appointed Professor of Mechanical Engineering at Northwestern University. In 1942 he became Chairman of the Department of Mechanical Engineering at Northwestern. Because of his activities in research, Professor Jennings has pursued many interests in the fields of thermodynamics, psychrometry, human engineering, fluid flow, gas turbines and compressors, ventilation, air conditioning and atomic energy, and is the author of numerous research papers and articles in these fields. In addition, he prepared the refrigeration section for the Kent Handbook, was Editor-in-Chief of the 1949 and 1951 editions of the ASRE Data Book and was founder and editor of Lubrication Engineering from 1944 to 1950.

Edwin L. Gannaway is now Assistant Chief Engineer of Copeland Refrigerator Corporation, in charge of Copelaweld compressor design. He joined the company earlier this year, coming from Bendix-Westinghouse and Tecumseh Products, where he had held positions in advanced compressor engineering. He had also been associated with the Haughton Elevator Company.

K. L. Lamm, appointed to the newly created position of Chief Application Engineer, Penn Controls, Inc., will assist the Field Sales Div in solving special application problems, supervise field testing of new products and make technical facilities available to customers. Other ASHRAE members taking new positions with Penn are **Harold S. King,** now Manager of the Atlanta district sales office, and **C. P. Pestow,** transferred from his previous post as Manager of the Philadelphia office to Manager of the Chicago office.

Carl T. Ashby has been appointed Director of Engineering for Norge Div, Borg-Warner Corporation, having resigned from his position as President and Director of Engineering for Conrad, Inc. His headquarters will be at the Muskegon Heights, Mich., plant. President of Conrad since 1956, his prior association was with Servel, Inc., where in his 22 years with the firm he served in the various capacities of Research Engineer, Director of Development and Chief Engineer. Previous to joining Servel, he was part-time instructor in chemistry at the University of Texas, where he achieved his Ph.D. in physical chemistry. As a member of the former ASRE he served on the Technical Committee, authored Chapter 5 on Absorption Refrigeration and co-authored Chapter 24 on Absorption and Steam Jet Units for the 8th edition of the Data Book. A member of the American Chemical Society, Institute of Environmental Engineers, American Ordnance Association and the International Organization for Vacuum Science and Technology, he holds 17 U. S. patents. In addition, he has worked as a member of American Standards Association Committees B-38 on Standards for Household Refrigerators and Freezers and Z-21, the American Gas Association Approval Requirements Committee for Gas Refrigerators.

Edward L. Crosby, ASHRAE Fellow, died on July 22nd at the age of 72. A graduate of the University of Pennsylvania (B.S.M.E. 1910), he was associated with Henry Adams, Inc., Consulting Engineers, as President from 1930 to 1947 and as Treasurer from 1947 until his retirement in 1958. He continued

Others are saying——

that . . . . . although the steady-state heat flow equation provides an adequate basis for much design work, there are cases where periodic variations of outside temperature and solar radiation have to be taken into account. Purpose of this article is to give, for the simpler types of structure, methods for determining the alternating transmittances and time-lags which are required in calculation of heat flow under periodically varying conditions. *Journal of the Institution of Heating and Ventilating Engineers, July 1960, p 136.*

that . . . . . building entrances open summer and winter yet keeping conditioned air in utilize an air screen several feet thick and as wide as the entrance. This air stream is blown gently out of a grille in the ceiling and is sucked in through a floor grating in a continuous cycle. A primary design question is the quantity of air necessary for a specific installation, which depends on the difference in pressure between inside and outside. Several factors affecting pressure differential are: height of structure (stack effect in tall buildings); orientation, whereby an entrance facing into a prevailing wind is difficult to seal by an air stream unless a wind screen is used; and degree of pressurization of the building. *Architectural Record, August 1960, p 212.*

that . . . . . rapid or slow response of a heating plant is largely dependent on the thermal mass of the system, a plant with a large thermal mass requiring a longer period of time to elapse before it is yielding full output than is required by a plant with lower thermal mass. Reduction in thermal capacity may be achieved by use of steel rather than cast-iron radiators, radiators of low water content and thin-walled pipes of small diam. This will enable the same rapidity of heating-up to be achieved by a smaller boiler, yielding a saving in fuel. *Journal of the Institute of Heating and Ventilating Engineers, August 1960, p 179.*

BULLETINS

Packaged Air Conditioners. Discussed in 12-page Bulletin 8825 are performance characteristics and engineering features of this line of packaged air conditioners. Typical installation illustrations, showing unit with and without discharge plenum, are included to demonstrate advantages of the units. A reference table is provided to give physical data and to indicate the range of capacities available in the line.
American Radiator & Standard Sanitary Corporation, Industrial Div, Detroit 32, Mich.

Gas-Fired Unit Heaters. Designed for installation at heights up to 36 ft, vertical discharge units described in six-page Bulletin IGV-660 deliver large volumes of air at high velocities to heat working areas in industrial locations. Heating capacities of the units are 300,000, 450,000 and 600,000 Btu/hr input, with motors ranging in size from ½ to 1 hp.
Modine Manufacturing Company, 1500 DeKoven Ave., Racine, Wisc.

Heat Exchanger. Descriptive of the Rotary-X-Changer, an air-to-air heat exchanger designed to recover heat from contaminated exhaust air or cool incoming fresh air into refrigerated spaces, is a new bulletin.
Heat Recovery Corporation, 671 Mt. Prospect Ave., Newark 4, N. J.

Under-Eaves Ventilator. Designated Model 624, this new under-eaves (soffit) ventilator is offered in two sizes, 16 x 4 and 16 x 8 in., for use in conjunction with roof or attic ventilators. Descriptive of the unit is Flyer 282-L.
Leigh Building Products Div, Air Control Products, Inc., Coopersville, Mich.

Induction Conditioners. Table of contents listing for 16-page Bulletin K110.05-TM includes: types of units; features; specifications, basic unit; dimensions, basic unit; specifications, enclosures; dimensions, enclosures; performance data; method of selection; rating data; and engineering specifications. Air conditioners discussed, available in three models with 12 capacity sizes, are designed for use with conventional induction unit systems where increased primary air quantities are required.
York Div, Borg-Warner Corporation, York, Pa.

his association after retirement as a consultant to the organization. Prior to joining Adams, he gained experience in plant operation, equipment design and maintenance with such companies as Pittsburgh Valve, Foundry and Construction, Edgewater Steel and Standard Sanitary Manufacturing Company. An active member of the former ASHAE since he joined in 1936, he has served on the Nominating, Long-Range Planning, Chapter Relations, Chapters Conference (delegate), Admission and Advancement (Chairman), Charter and By-Laws Committees. Instrumental in formation of the Baltimore Chapter, he was a Charter Member and first President (1949).

William E. Hood has been appointed Chief Engineer of Carrier Corporation's Unitary Equipment Operation, a major department of the newly formed Carrier Air Conditioning Company. Prior to this appointment he served as Assistant Manufacturing Manager of the former Unitary Equipment Div. A graduate of the University of Wisconsin, Mr. Hood, who joined Carrier in 1942, will fill the vacancy created by the recent appointment of **W. L. McGrath** as General Manager of the Unitary Equipment Operation.

Louis C. Plaehn, deceased (July 16th), had been a branch manager for Barber-Colman Company. Educated at Cornell and Colorado University, he joined the Society in 1948 and became affiliated with the Wisconsin Chapter. He was Chapter Secretary in 1950-51, Treasurer 1951-52, Vice President 1952-53 and President 1953-54. In 1951-52 he was a member of the Radiant Heating Committee, from 1952-54 a member of the Guide Committee and from 1956-59 Chairman of the Gustus L. Larson Award Committee.

Carroll O. Hutchinson is newly appointed Market Development Manager of the Industrial Paint Div, Glidden Company. Since his association with Glidden, which began in 1945, he has served as Technical Service Director and Industrial Sales Manager for the Midwest Region. Author of numerous technical articles on finishing materials and methods, he is an alumnus of the University of Cincinnati and a member of ASHRAE, American Chemical Society and the National Association of Corrosion Engineers.

Frank C. Hawk of Hawk Engineering Company is Ansul Chemical Company's new agent for northern New Jersey and metropolitan New York. In this capacity he will handle sales to wholesalers and original equipment manufacturers. In addition to ASHRAE membership, he is a member of Refrigeration Service Engineers Society and has had 25 years of experience in the refrigeration industry.

James M. Ballard, Jr., has been promoted to Manager of Trane Company's Birmingham, Ala., office. A 1949 alumnus of the University of Louisville, he joined Trane in 1950 as a sales engineer and completed the specialized course in air conditioning and heating for graduate engineers at the home office in La Crosse, Wisc., prior to his assignment to Louisville, where he had been until his recent appointment.

Graeme B. Supple, appointed Director, Product Development, Air Conditioning Systems for American Radiator & Standard Sanitary Corporation's Industrial Div, will have his office in the engineering sect at the Div's home office in Detroit. With American-Standard since 1927, he has served in a variety of engineering and sales management positions. Prior to his new appointment, he had been on the staff of the vice president, marketing, in charge of future planning and development for products on the air side of air conditioning product lines.

William McIntosh Andrews, a partner in the engineering firm of Lockwood, Andrews and Newman, died recently at the age of 50. Active in engineering since graduation from Texas A & M in 1931, he was Chairman of the Board for Texas State Board of Registration for Professional Engineers and a member of the Texas Society of Professional Engineers (past-President of San Jacinto Chapter). In addition to ASHRAE, he was a member of the American Society of Mechanical Engineers and the American Institute of Consulting Engineers.

BULLETINS and CATALOGS

Electric Unit Heaters. Supplementing a line of steam, hot water and gas-fired unit heaters, this manufacturer announces, in four-page Bulletin 1060, addition of seven new electric units. Capacities range from five to 25 kw, with models available for 208, 240, 277 and 480 volt. Supplied in the bulletin is extensive descriptive and specification information.
Modine Manufacturing Company, 1500 DeKoven Ave., Racine, Wisc.

Vibration and Noise Control Products. Engineering specifications and performance data for 27 types of products for control and measurement of machinery vibration, shock and noise are presented in eight-page Bulletin K4G. Actual installation photographs show a variety of equipment and indicate how typical problems were solved. Contained is a detailed discussion of the relative merits of steel springs and organic materials as isolation media. A special feature is a selector chart covering an extensive range of equipment, showing recommended and alternate methods of isolation and indicating when concrete foundations are necessary.
Korfund Company, Inc., 53D Cantiague Rd., Westbury, N. Y.

Insulation Panels. Subject of a four-page bulletin is insulation comprised of rigid polyurethane foam, available in four by eight-ft panels with waterproofed plywood facing for use in warehouses and refrigerated vehicles. K factor of the material is cited as being 0.11. Properties, application, installation and advantages are covered in the bulletin.
Urefoam Corporation, Box 553, Camden, N. J.

High Velocity Mixing Boxes. Contained in eight-page Technical Catalog HV-100 are extensive performance data, dimensions and illustrations of Type O mixing boxes and attenuation chambers. Only one motor is utilized on the units to operate the mixing valves which proportion hot and cold air in response to a room thermostat. Ceiling and under-window types are available.
Air Devices, Inc., 185 Madison Ave., New York, N. Y.

Demineralizer. Barnstead Mixed-Bed, Two-Bed and Four-Bed demineralizers are featured in 36-page Catalog 160. A section is devoted to "Train" equipment which produces pure water of 18,000,000 ohm resistance at 25 C. Equipment also removes organics, inorganics, bacteria, gases and submicroscopic particles down to 0.45 micron. Described are tin-lined piping, fittings, faucets, purity meters, storage tanks, sand and carbon filters, submicron filters and other auxiliary equipment.
Barnstead Still and Sterilizer Company, 275 Lanesville Terrace, Boston 31, Mass.

Water-Cooled Condensers. Emphasized in eight-page Bulletin WC-300 are advantages of counter-flow, offered for max heat exchange over the total length of condenser tubes by this manufacturer and cited as producing an average of 7½% more system capacity without additional power input. Designed for refrigeration and air conditioning systems where min space requirements prevail, condensers listed in the bulletin are offered in sizes from 1/3 to 25 ton in standard, heavy-duty, R series close-coupled, WR series multi-section and SW series for operation on sea water or under corrosive conditions. Charts showing water consumption and pressure drops are included.
Halstead & Mitchell Company, Bessemer Bldg., Pittsburgh 22, Pa.

Impinged Jet Burners. Btu specification and physical dimensions of 24 models of the impinged jet type are compared with as many of the slotted cap jet design in a six-page bulletin. The impinged jet burner generates a temperature of 1900 F for applications where intense heat released at low level is important.
Barber Manufacturing Company, 1052-60 East 134th St., Cleveland 10, Ohio.

Centrifugal Fan. Designated Centriline, this straight-line flow centrifugal fan, ranging in volume from 4700 to 46,800 cfm, is the subject of 16-page Bulletin 1125. Compact design makes possible installation on ceiling, wall or stacked one above the other, saving floor space. Use of an airfoil-bladed centrifugal wheel enables air to follow blade contours closely, preventing noise producing turbulence on upper blade surfaces. Six sizes are available, with airfoil wheels from 27 to 44½ in. diam, all of unobstructed design with no intermediate rings or stay rods to interfere with quiet air flow. Contents of the bulletin include features, optional accessories, inlet vane air spin control, effects of temperature and altitude, application and selection, typical specifications, dimensions and performance and engineering data.
Westinghouse Electric Corporation, Sturtevant Div, Hyde Park, Boston 36, Mass.

Aluminum Roof Coating. For application on roofs of farm buildings, factories, mobile homes and other structures, aluminum roof coating is discussed in six-page Bulletin 6471. Included in the folder is information on how the coating prolongs roof life, seals in protection, reflects actinic rays of the sun, seals out moisture, reduces maintenance costs and conditions buildings. Easy-to-apply instructions and coverage capacity of both fibrated and non-fibrated coating are listed.
Philip Carey Manufacturing Company, 320 S. Wayne Ave., Cincinnati 15, Ohio.

Leak Detection. Bulletin GEA-6827A, ten pages, discusses Type H-6 halogen leak detector and accessory equipment. Recommended methods for finding refrigerant leaks down to ½ oz a year and for quantitative measurement of leaks are described in detail. Included are prices and information on three leak detector models: an economy unit with halogen reference source, a general purpose model with portable leak standard and an all-purpose kit that includes a leak standard and a special proportioning probe to permit location of leaks in highly contaminated atmospheres.
General Electric Company, Schenectady 5, N. Y.

Unit Ventilator. Advantages of this unit for schoolroom heating, cooling and ventilating are described in a 16-page booklet. In addition to sections dealing with product features, cost, engineering information and ratings, the booklet includes a fold-out spread illustrating ventilator operation through an exploded view of its components. Also discussed are matching unitized cabinets designed to complement the ventilator and several other elements in this system, including convectors, Walvector, cabinet unit heaters and steam specialties.
Warren Webster & Company, Inc., 17th & Federal Sts., Camden 5, N. J.

Candidates for ASHRAE Membership

Following is a list of 83 candidates for membership or advancement in membership grade. Members are requested to assume their full share of responsibility in the acceptance of these candidates for membership by advising the Executive Secretary on or before October 31, 1960 of any whose eligibility for membership is questioned. Unless such objection is made these candidates will be voted by the Board of Directors.

Note: * Advancement † Reinstatement

REGION I

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PRITZKER, P. E., Elec. Engr., Empire Electric Contractors, Inc., Boston.

New York

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BILLHARZ, R. W., Cons. Engr., North Tarrytown.
FROST, G. C., Partner, Rist, Bright & Frost, Glens Falls.
HADJIAN, J. N.,* Mech. Engr., C. B. S. New York.
HUDELSON, G. D.,† Sr. Engr., Carrier Corp., Syracuse.
KEDENBURG, F. V., JR.,* Pres., F. V. Kedenburg Co., Highland.
RASCH, J. H., Com. Div. Sales Engr., Minneapolis - Honeywell Regulator Co., East Syracuse.
RICE, J. B., Engr., Daniel J. Rice, Inc., Long Island City.
RUTIGLIANO, FRANK, Proj. Mgr., Syska & Hennessy, Inc., New York.
SAUER, W. E., Sales Engr., York Corp., New York.
VICTORY, E. J.,* Proj. Engr., Voorhees Walker Smith Smith & Haines, New York.

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PELLATT, R. L., Chief Engr., Vice-Pres., Lloyd A. Book, Ltd., Brantford, Ont.
THORNE, E. W., Proj. & Sales Engr., Goodram Bros. Ltd., Hamilton, Ont.
TROTT, W. L., Design Engr., Canada Packers Ltd., Toronto, Ont.

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KLAWANS, W. D., Sales Engr., Powers Regulator Co., Baltimore.
PETROSSIAN, RAFAYEL, Engr., C. Warren Bogan & Assocs., Bethesda.
REESE, G. R.,* Sales Engr., J. E. Perkins Corp., Baltimore.
SCHOVERLING, RALPH, Br. Mgr., Powers Regulator Co., Baltimore.

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CLARK, J. A., Purch. Mgr., Limbach Co., Pittsburgh.
KRONFOL, ISSAM, Student, Refr. Training Course, Frick Co., Waynesboro.
LADLEY, C. H., Refr. Specialist Sales, Williams & Co., Inc., Pittsburgh.
MACINTOSH, D. R.,* Vice-Pres., Treas., Mack Engineering Corp., Philadelphia.
YOUNG, E. A., Refr. Specialist Sales, Williams & Co. Inc., Pittsburgh.

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COHEN, WALTER, Vice-Pres. & Gen. Mgr., Delta Heating Co., Atlanta.
DEAN, B. W.,* Design Engr., Robert Co., Atlanta.
STRANGE, J. P., Gen. Mgr., A-C Dept., Thoben Elrod Co., Atlanta.

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MCGUIRE, N. W., JR.,* Asst. Mgr., American Standard, Ind. Div., Charlotte.

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WUEST, L. M., Sales Repr., J. E. McCormick Co., Evansville.

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COOK, C. W.,* Partner, DeLong & Cook, Bellefontaine.
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GAY, N. R.,† Research Engr. Prof., A. and M. College of Texas, College Station.
RICH, H. M., Pres., Phil Rich Fan Mfg. Co. Inc. & Ventco Inc., Houston.
WORK, P. T., Engr., General Electric Co., Tyler.

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ELDER, H. K., Mech. Engr., U. S. Army Corps Engineers, San Francisco.
TIEDEMANN, J. J. JR., Field Engr., Powers Regulator Co., Los Angeles.
TYERMAN, V. J., Sales Mgr., Laars Engineers, Inc., North Hollywood.
WARREN, A. W. SR., Design Engr., Cal-Air Conditioning Co., Los Angeles.
WECKERLY, ALLEN,* Engr., San Diego Sheet Metal, San Diego.

(*Continued on page* 112)

follow Scovill's suggested 5 point program

for pride in your installations and service to your customer.

SPECIFY AND INSIST UPON BRANDED U.S.-PRODUCED MATERIALS.

★

INSTALL ONLY SERVICE-PROVED MATERIALS USING TIME-TESTED METHODS.

★

DEMAND CLEAR IDENTIFICATION OF ALL MATERIALS IN ACCORDANCE WITH U.S. INDUSTRY STANDARDS AND CODES.

★

SPECIFY BRANDS YOU KNOW AND RESPECT . . . MADE BY U.S. CRAFTSMEN.

★

BUY FROM YOUR NEIGHBOR-WHOLESALER WHO IS PLEDGED TO GIVE YOU RESPONSIBLE, CONTINUING SERVICE.

★

MADE IN USA

and made better to bring out the BEST in every installation

THERE'S NO FINER ***quality control*** THAN THAT WHICH SAFEGUARDS

SCOVILL ®

copper refrigeration tube

COPPER WATER TUBE K-L-M

COPPER THREADLESS PIPE (TP)

RED BRASS PIPE

COPPER PIPE

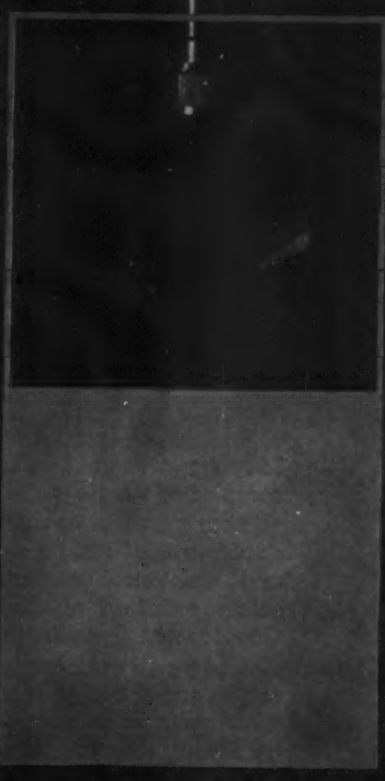
COPPER DRAINAGE TUBE (DWV)

PLUMBERS BRASS GOODS

SCOVILL MANUFACTURING COMPANY · COPPER TUBE MILL PRODUCTS, WATERBURY 20, CONN.

10SC60

ON THE HIGH COST OF VIBRATION IN AIR MOVING EQUIPMENT

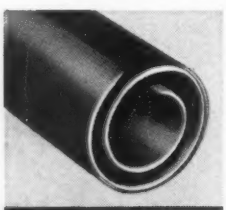


Have you considered the fact that normal excitation in your product can produce resonance and structural failure in the air moving components? We have, and this fact is "pocketbook and problem insurance" for our customers. For instance: We know that motor rotational frequencies... blade frequencies... magnetic frequencies... are basic sources of excitation present in every fan or blower application. When the above coincides with the natural response of the unit, this means resonance and—plenty of trouble. At Torrington, each product of ours is designed, engineered and tested for an optimum range of performance, with harmful or costly resonances "designed out." It pays to know these performance characteristics—and to take advantage of this kind of knowledge. Check your air moving problems or your products with Torrington.

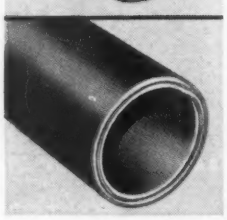
THE TORRINGTON MANUFACTURING COMPANY

AIR MOVING DIVISIONS Torrington, Connecticut; Van Nuys, California; Rochester, Indiana; Oakville, Ontario

There's almost no limit to the things Bundy can mass-fabricate



Bundyweld is the original tubing double-walled from a single copper-plated *steel* strip, metallurgically bonded through 360° of wall contact for amazing strength, versatility.



Bundyweld is lightweight, uniformly smooth, easily fabricated. It's remarkably resistant to vibration fatigue; has unusually high bursting strength. Sizes up to ⅝" O.D.

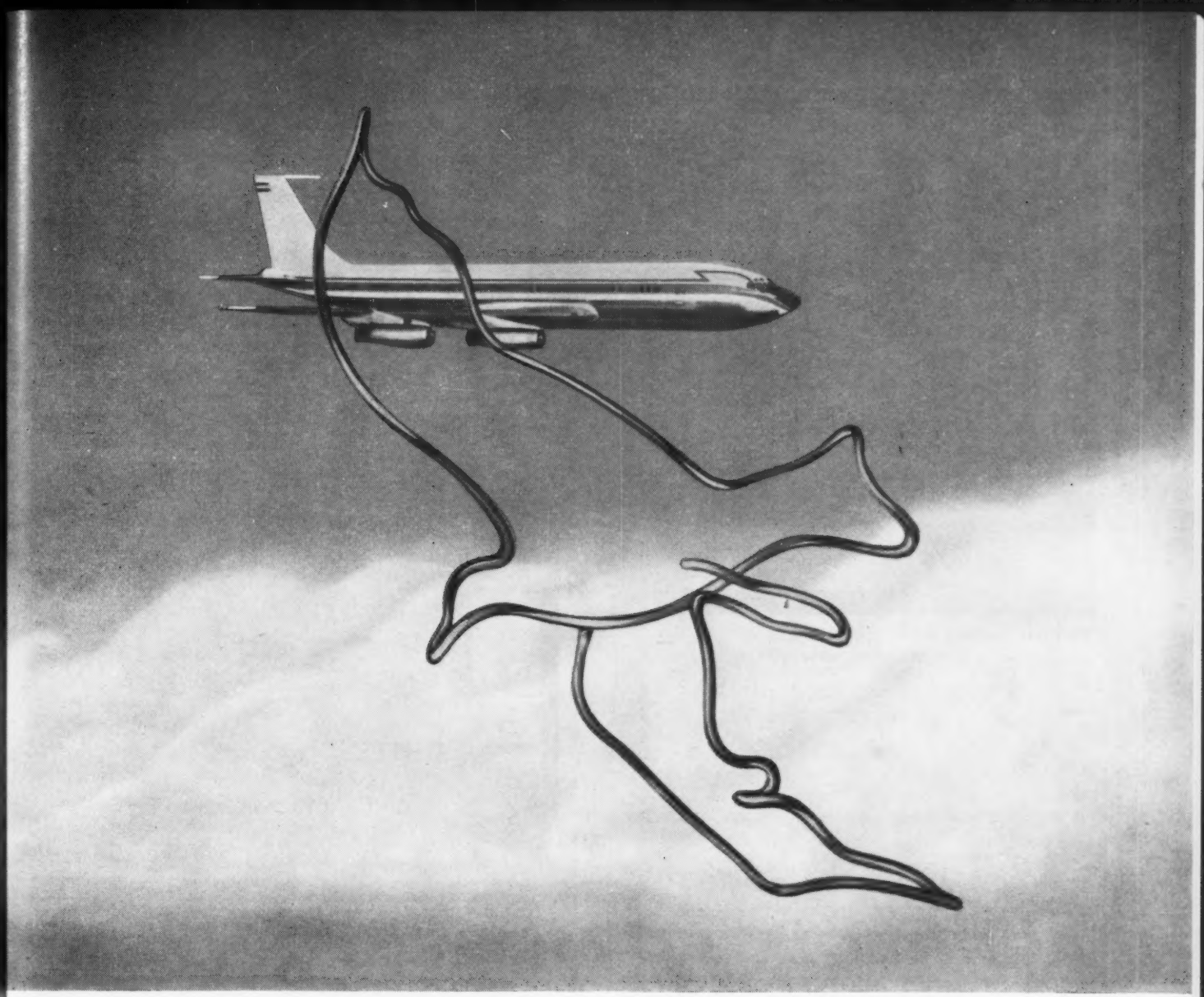
Maybe you've got a tubing component that's difficult to fabricate. Bu complex or simple—it will still pay you to talk to Bundy. Here's why

Your part will be made from Bundyweld—the original steel tubin *double-walled* from a single copper-plated steel strip. Extra strengt and resistance to vibration fatigue have made Bundyweld th safety standard of the refrigeration industry. Meets ASTM 254 Government Specification MIL-T-3520, Type III.

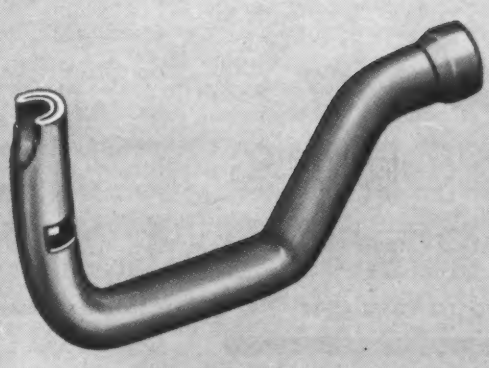
And you'll get close tolerances, too. Bundy engineers check ever job to see if design modifications can cut costs or improve quality Then your component will be mass-produced on machines develope by Bundy to give you precision and uniformity – and low unit cos

Need help with a tubing problem? Bring it to Bundy. Call, writ or wire: Bundy Tubing Company, Detroit 14, Michigan.

WORLD'S LARGEST PRODUCER OF REFRIGERATION TUBING



Tight tolerances in bending, crimping, expanding and slotting are essential in this oil sprinkler tube for General Electric refrigerator compressors. The sprinkler slots are especially critical because they regulate the rate and direction of oil flow in lubricating and cooling vital parts of the high-speed compressor motor.

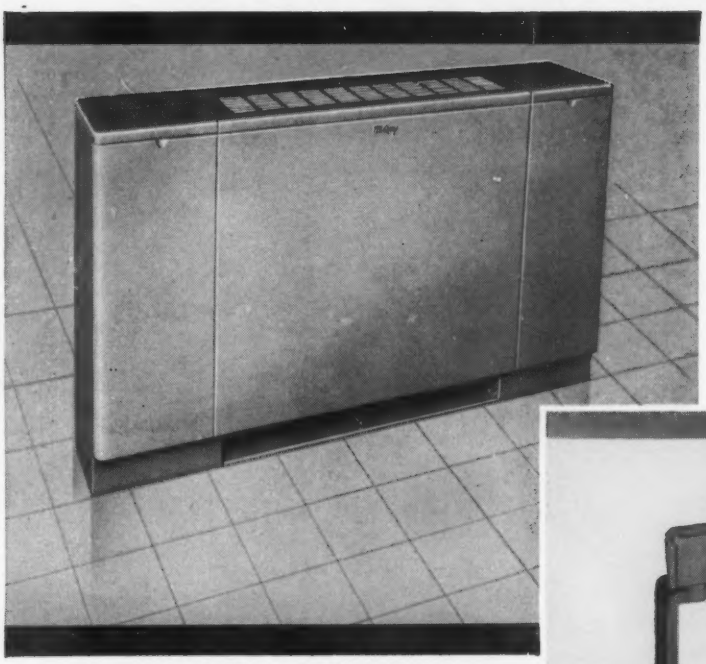


There's no substitute for the original

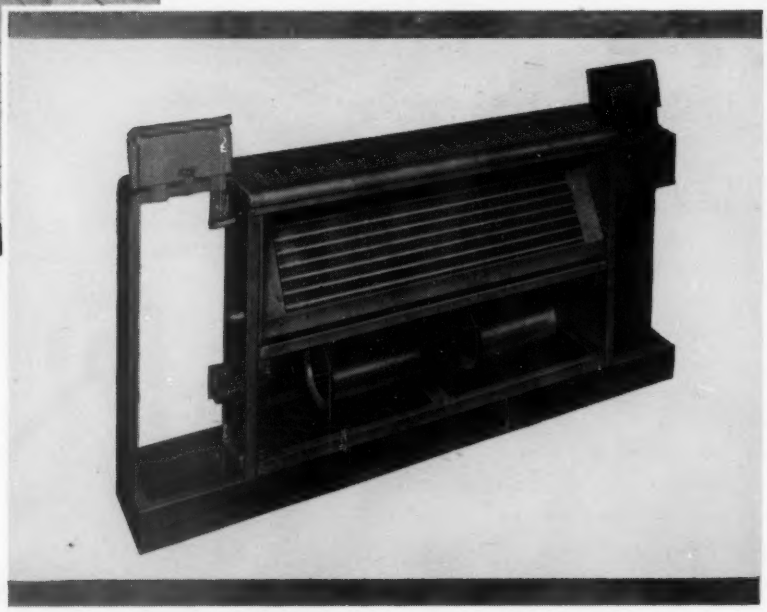
BUNDYWELD® TUBING

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING • AFFILIATED PLANTS IN AUSTRALIA, BRAZIL, ENGLAND, FRANCE, GERMANY, ITALY, JAPAN

BUNDY TUBING COMPANY • DETROIT 14, MICH. • WINCHESTER, KY. • HOMETOWN, PA.



EXTRA LARGE PIPING COMPARTMENTS • COMPLETE SLIDE-OUT FAN DECK ASSEMBLY • MOTOR DISCONNECT PLUG • FIELD REVERSIBLE COILS • FILTER REMOVAL WITHOUT REMOVING PANELS • ADJUSTABLE LEVELING LEGS • REMOVABLE PANELS FOR EASY INSTALLATION • FULL RATED CAPACITY • QUIET, EFFICIENT OPERATION • QUALITY MATERIALS CRAFTED BY QUALITY WORKMANSHIP • BAKED ENAMEL FINISH ON BONDERIZED GALVANIZED STEEL.



You get more built-in quality and performance with McQuay features

APPRECIATED MOST

by those who specify, install and use individual room

McQUAY *thin-line design* SEASONMAKERS

NOW
4 MODELS
7 SIZES
220 TO 1240 CFM

8½" thin, 25" high

McQuay thin-line design Seasonmakers are extremely versatile, dependable and exceptionally easy to work with. That's why engineers, contractors and building operators alike appreciate them most. These remote, individual room units are ideal for apartments, motels, hotels, offices, hospitals or any installation utilizing a central station heating and cooling system. They are available in four types in seven sizes. Floor and basic models are made in sizes from 220 to 1240 cfm; hide-away and ceiling models from 220 to 640 cfm.

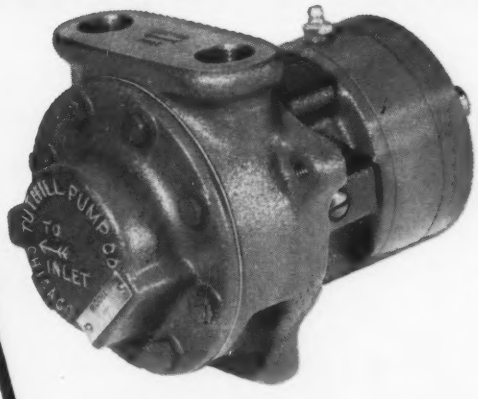
Investigate the many advantages these thin-line design McQuay Seasonmakers can offer you on your next job. Contact your local McQuay representative, or write McQuay, Inc., 1606 Broadway Street N.E., Minneapolis 13, Minnesota.

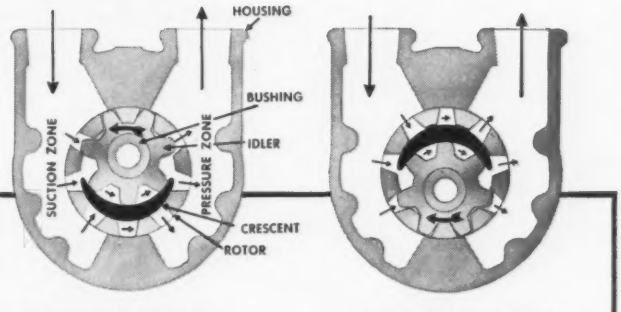
McQuay INC.

AIR CONDITIONING • HEATING • REFRIGERATION

TUTHILL automatic reversing pumps

- **Positive reversing action**
- **Require no valves**
- **Port positions remain constant**





COUNTER-CLOCKWISE ROTATION

CLOCKWISE ROTATION

The model RCK above is typical of Tuthill's complete line of automatic reversing pumps . . . which use the time tested operating principle at the right to provide instantaneous, positive reversing action without the use of valves. The port positions remain constant regardless of the direction of shaft rotation. And all pumps provide uniformly high efficiency in both flow directions.

The automatic reversing design was developed by Tuthill for applications where the pump must be driven from a reversing shaft, or where machinery must be shipped without knowing the ultimate direction of the driving unit. These pumps have been enthusiastically accepted by designers and have proven their dependability in thousands of demanding applications such as large air compressors and machine tools.

375 Models

A complete selection of 375 models is provided with capacities from ⅓ to 200 gpm; for pressures to 400 psi; and speeds to 1800 rpm. Included are a complete assortment of stripped models specially developed for incorporation into manufactured products.

A 12-page catalog, No. 105, gives complete information on all Tuthill automatic reversing pumps. Write today for your copy. Or, if you desire, send drawings so that Tuthill's engineers can show you how the Model R reversing pump can be built directly into your product.

THE PUMPING PRINCIPLE

Tuthill automatic reversing pumps are based on the use of a rotor, idler gear and a crescent shaped partition which is integral with a moving part called the Idler Carrier.

Figure 1 shows how power is applied in counter-clockwise rotation to the rotor and transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler and the inside diameter of the rotor is sealed by the crescent. When the pump is started there is an increase in volume as the teeth come out of mesh. This creates a partial vacuum, drawing the liquid into the pump through the suction port. The liquid fills the spaces between the teeth of the idler and rotor and is carried past the crescent partition to the pressure side of the pump. When the teeth mesh on the pressure side, the liquid is forced from the spaces and out through the discharge port.

When the shaft rotation changes from counter-clockwise to clockwise, the idler carrier (including the idler gear and crescent) automatically rotates 180° through the suction zone to the position shown in Figure 2 which *changes the direction of flow within the pump* without changing port positions. The idler carrier rotates in a cover casting fitted with stops so that the crescent can rotate only 180°—always through the suction zone. Upon resumption of counter-clockwise rotation, the crescent will swing back to the original position in Figure 1.

Tuthill Manufactures a Complete Line of Positive Displacement Rotary Pumps in Capacities From ⅓ to 200 GPM; for Pressures to 1500 PSI; speeds to 3600 RPM.

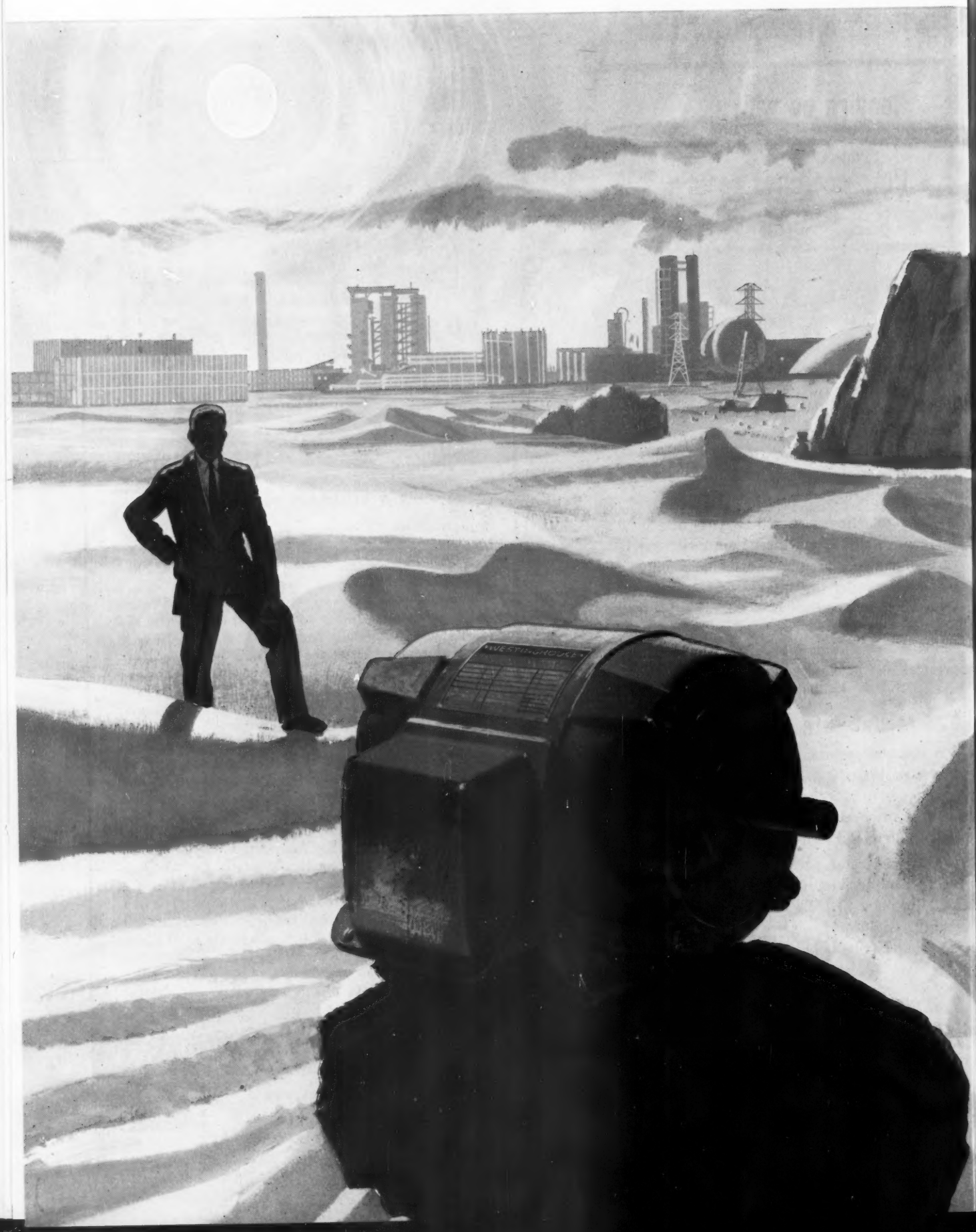
PUMPS FOR YOUR PURPOSE

TUTHILL PUMP COMPANY

969 East 95th Street, Chicago 19, Illinois

NFPA NATIONAL FLUID POWER ASSOCIATION

NEW WESTINGHOUSE *Guardistor*



MOTORS LET YOU USE ALL THE HORSEPOWER YOU PAY FOR...SAFELY

The man and the motors from Westinghouse now provide absolute protection against motor failure caused by excessive heat . . .

Our Engineering Manager says:
"With the breakthrough development of the Westinghouse Positive Temperature Coefficient thermistors, for the first time we can provide inherent protection against motor failure caused by excessive heat. The solid-state thermistors buried in the windings instantly sense excessive heat from any cause and simultaneously warn of trouble or automatically take the motor off the line. Thus, motor protection is placed where only true motor protection can be . . . in the windings."

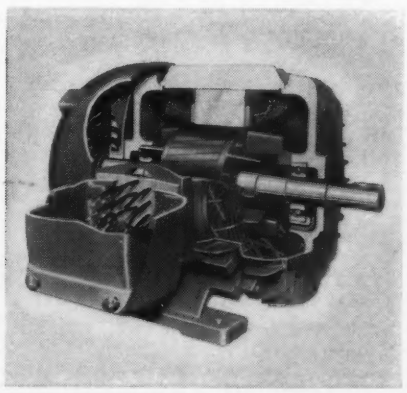
Our Marketing Manager says:

- "You can match the motor to the load . . . use all the motor you are paying for.
- Provides positive protection based on winding temperature . . . *not* load current and/or power supply fluctuations.
- Eliminates time and expense of changing winter-summer heaters. No nuisance tripping, it's fail-safe . . ."

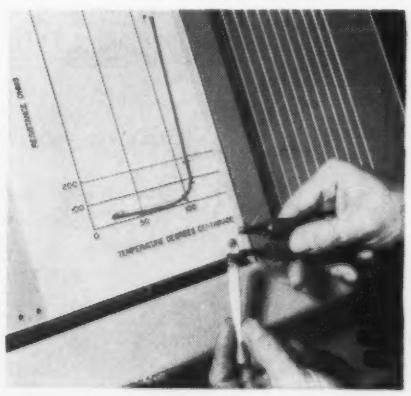
Call your Mr. Westinghouse for the application of a Guardistor* motor to your drive requirements . . . write for *Questions and Answers About . . . Guardistor* (B-7876). Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. You can be sure . . . if it's Westinghouse.

*Trade-Mark

J-22160-R



Unlike remotely located sensing devices, PTC thermistors are buried in the windings of the Guardistor motor, instantly equating all temperature factors.



Ever alert PTC thermistors constantly totalize temperature, statically triggering an action *only* if critical temperature is reached.

MOTOR & GEARING DEPARTMENT

Westinghouse

PARTS and PRODUCTS

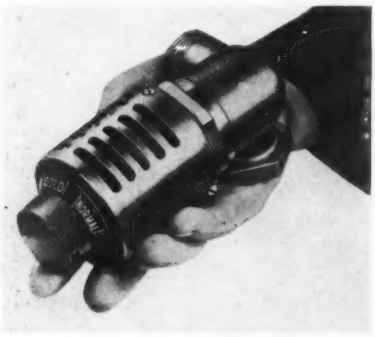
SCALE REMOVER

Scale, slime and algae removal and rapid head pressure reduction on air conditioning systems are cited as being possible without danger of acid burns or metal corrosion with a newly developed liquid scale remover, Scalex. Non-toxic, the liquid contains no hydrochloric or other fuming acids; does not corrode copper, brass, aluminum or steel; will not attack wooden or painted towers and creates no acid fumes to contaminate surroundings. No neutralization is required and no damage results from leaving Scalex in the system for longer than the recommended treatment time.

Lester Laboratories, Inc, P. O. Box 4897, Atlanta 2, Ga.

TEMPERATURE CONTROL

Completely self-contained, requiring no connection to any external device or power supply and easily installed, Thermotrol is an efficient, compact



temperature control unit which can be installed on any radiator. Not an on-and-off control, it modulates the flow of steam or water to the radiator to maintain a constant temperature within 1½ F. Settings may be adjusted by turning a graduated dial to any point between 60 and 80 F.

Sterling, Inc., 5201 W. Clinton Ave., Milwaukee 23, Wisc.

EXPANSION JOINTS

Now available for hot water and steam heating installation on straight baseboard runs of 25 ft or more are expansion joints for water temperatures ranging from 100 to 250 F. Joints have a large bronze bellows with copper tubing electronically welded at each end for sweat connections. Two large sized laminated fiber rings are provided to assure a completely water-tight unit. Each fiber ring is protected on both sides with a heavy-gauge cadmium-plated ring, perforated to assure wetting and drying of the rings. Bellows and disc assembly are encased in a brass protective cover, made with integral limit rings for both max and min positions. Recommended max pressure for hot water is 45 psi, for steam applications 15 psi.

Modine Manufacturing Company, 1500 DeKoven Ave., Racine, Wisc.

PNEUMATIC CONTROLLER

For liquid level applications, Model J-2, a non-bleed pneumatic controller, is magnet-actuated and snap acting. Unit is equipped with an all-stainless steel, three-way air valve. In one valve position (high level), air is allowed to flow from the air supply line directly to the pneumatic actuator: in the other position (when liquid reaches low level), supply air is cut off and entrapped downstream air exhausts to atmosphere.

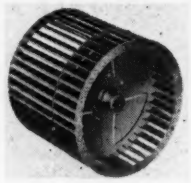
Dual magnet design is cited as giving positive snap action in both switching directions. Unit has a high air capacity, operating against 40 psi max as standard and up to 100 psi with special construction. In many applications, the J-2 and diaphragm valve can be powered by the gas in the pressure vessel where liquid level is being controlled, becoming a self-operating installation.

Anti-corrosive design features include Type 316 stainless steel all-metal valve with metal-to-metal seats, and all screw adjustments have self-locking nuts for ease and accuracy of adjustment. Switch head can be rotated 360 deg for ease in installing air connections. Operating temperature is 450 F.

Magnetrol, Inc., 2110 S. Marshall Blvd., Chicago 23, Ill.

BLOWER WHEELS

Greater flexibility of design for central air conditioners is cited as being made possible by new features introduced in these double and single-inlet blower wheels. Offered in double-inlet wheels is a single center disc that can be positioned wherever desired, permitting adaption of the wheel to specific needs of a design. Hubs on both wheel types are available in either Ledloy steel or aluminum construction. An extensive selection of aluminum blower wheels has been developed for direct drive applications.



Revcor, Inc., 251 Edwards St., Carpentersville, Ill.

ICE FLAKE MACHINE

Featured on this new unit is an ice auger set in an evaporator of wrapped-coil construction designed to obtain max freezing. Entire auger assembly may be lifted out of the machine in seconds and completely disassembled to simplify cleaning and servicing. Ice-making mechanism and condensing unit are mounted on a platform which slides out the side of the cabinet for ready accessibility.

Two models are available: Model 25, equipped with a ¼-hp hermetic condensing unit and having a capacity of 250 lb of ice flakes in 24 hr, based on room temperature of 75 F and water temperature of 60 F; and Model 25-A, equipped with a 1/3-hp hermetic condensing unit and having a capacity of 300 lb. Both models are fully automatic in operation.

Freez King Corporation, 2518 W. Montrose Ave., Chicago 18, Ill.

AIR-TO-AIR HEAT PUMP

Ruggedly constructed for residential or commercial applications, all-electric air-to-air heat pumps have been introduced for both heating and cooling. Majority of the equipment is designed to be located out-of-doors, with only the fan and coil unit installed in an attic or basement. When used for commercial applications, the indoor unit may be suspended from the ceiling in the conditioned space for free delivery of air or used in connection with a system of duct work. For residential installation this may be placed in attics and crawlspaces, furred in above closets, enclosed by sub-ceiling partitions or suspended openly from the ceiling in a basement.

Only electrical and refrigerant connections are needed for installation. More efficient defrosting of the outdoor coil is featured on the heat pump, with only two rows of tubes being used with Sigma-Flo fins to provide a large face area and rela-

Continuous advertising to your customers helps expand the market for your equipment . . . backs your selling efforts . . . by reaching your customers in leading publications such as "Business Week", "House & Home" and others . . . year after year.

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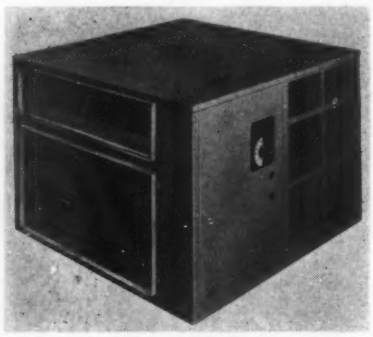
E. I. DU PONT DE NEMOURS & CO. (Inc.), "FREON" PRODUCTS DIVISION, WILMINGTON 98, DELAWARE

tively narrow coil width. This design is cited as providing adequate heat transfer area when coil surfaces are covered partially with frost.
Trane Company, LaCrosse, Wisc.

HEAT PUMP

Two sizes of a heat pump have been introduced for residential and light commercial applications, a two and a three-hp unit. Accessory strip heater packages for additional heating capacity in areas with lower winter temperatures are available. Installations supply coil filtered air in the



summer months and warmth during the winter, from a single, all-electric unit and duct system.

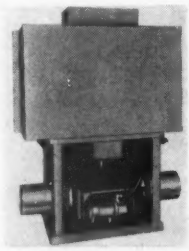
Residential installations can be made in the attic, basement, roof or a ground level slab outdoors. Commercial installations using several units can also be located on the roof, suspended indoors or installed mounted through an outside wall.

Compressor itself is sealed hermetically with thermal and overload protective devices. Outer casing of the unit has a three-coat protection against weather: electro-zinc coating on the steel and Epon primer coat plus melamine enamel surface coat, both baked to a hard, durable finish.

Factory-assembled supplemental heater units for installation in the discharge air outlet or elsewhere in the duct system are available in three-kw (10,239 Btu) increments.
Day & Night Manufacturing Company, P. O. Box 2222, La Puente, Calif.

MIXING BOXES

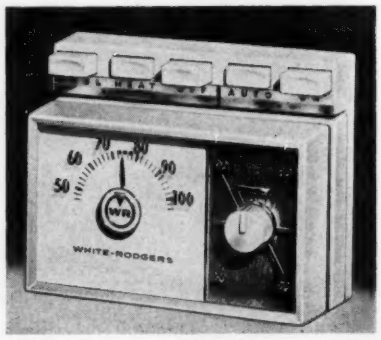
Simple design of these high velocity units is cited as eliminating all linkages and pivots. Only one motor is used to operate the mixing valves which proportion hot and cold air in response to a room thermostat, and an Agitrol volume regulator assures constant control of air delivery at the required volume. Attenuation chambers are designed to lower sound ratings. Type O mixing boxes are available in both ceiling and under window types.



Air Devices, Inc., 185 Madison Ave., New York, N. Y.

PUSHBUTTON THERMOSTAT

Offering selective pushbutton control of heating, cooling and ventilating, this unit combines a D'Luxline thermostat with a sub-base using pushbuttons for desired switching action. Eight different switching combinations are available to satisfy requirements of all heating-cooling systems, whether controlled from a single unit



or by change-over to a separate heating thermostat.

Sealed mercury contacts offer protection against corrosion, dirt and dust and operating differentials are approximately ½ F for heating and 1 F for cooling.
White-Rodgers Company, 1209 Cass Ave., St. Louis 6, Mo.

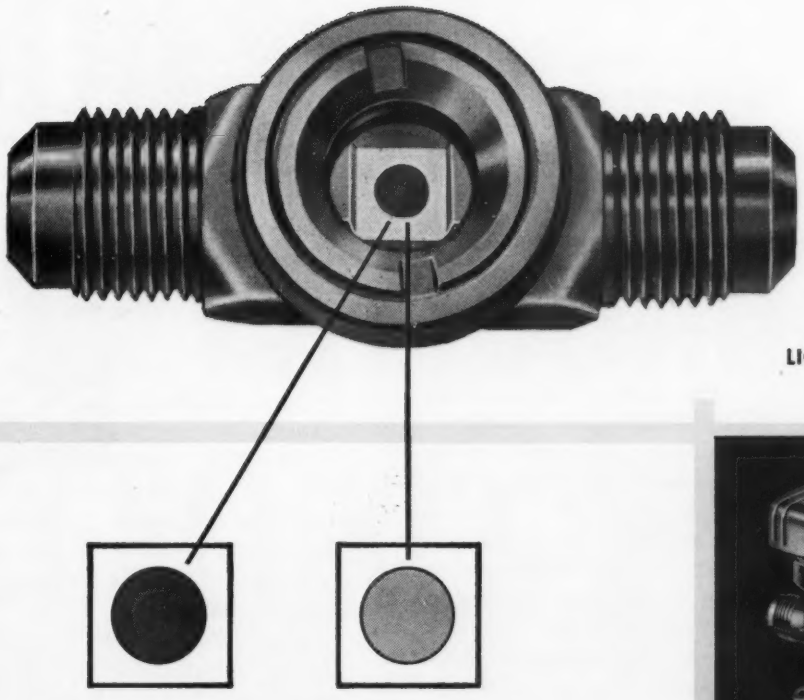
VIBRATION METER

Battery-operated and hand-carried, Type PR-9252 is a self-contained instrument reading peak amplitudes of both absolute and relative vibrations directly on its large meter dial. Readings are in micron, over a frequency range from five to 1200 cps. Unit has a measuring range from zero to 1000 micron value in five steps and a sensi-

(*Continued on page* 112)

CHAPTER MEETING DATES

	Oct.	Nov.	Dec.
Alamo	—	—	—
Arkansas	18	22	20
Atlanta	10	14	—
Austin	20	17	3
Baltimore	6	3	1
Baton Rouge	19	16	21
Boston	—	—	—
British Columbia	12	16	9
Central Arizona	3	7	5
Central Indiana	11	8	—
Central Michigan	11	8	13
Central New York	—	—	—
Central Oklahoma	10	14	12
Central Pennsylvania	12	9	14
Cincinnati	—	—	—
Cleveland	—	—	—
Columbus	—	—	—
Dallas	—	—	—
Dayton	11	8	13
El Paso	17	21	19
Evansville	4	1	6
Florida West Coast	—	—	—
Fort Worth	—	—	—
Golden Gate	—	—	—
Hampton Roads	4	8	6
Houston	21	18	23
Illinois	10	14	12
Illinois-Iowa	17	21	—
Inland Empire	10	14	12
Iowa	—	—	—
Jacksonville	—	—	—
Johnstown	11	8	13
Kansas City	—	—	—
La Ville de Quebec	—	—	—
Long Island	—	—	—
Louisville	10	14	10
Manitoba	27	24	—
Memphis	17	21	19
Michigan	—	—	—
Middle Tennessee	—	—	—
Minnesota	—	—	—
Mississippi	24	28	23
Mobile	24	28	19
Montreal	—	—	—
National Capital	12	9	14
Nebraska	11	8	13
New Mexico	—	—	—
New Orleans	—	—	—
New York	—	—	—
Niagara Frontier	3	7	19
Niagara Peninsula	4	1	—
North Alabama	—	—	—
North Jersey	—	—	—
North Piedmont	—	—	—
Northeastern New York	17	21	19
Northeastern Oklahoma	—	—	—
Northern Alberta	—	—	—
Northern Connecticut	13	10	—
Northern Ohio	—	—	—
Ontario	3	7	8
Oregon	13	10	15
Ottawa Valley	—	—	—
Panama & Canal Zone	—	—	—
Philadelphia	13	10	8
Pittsburgh	—	—	—
Puget Sound	—	—	—
Rhode Island	19	9	14
Richmond	—	—	—
Rochester	5	2	7
Rocky Mountain	—	—	—
Sacramento Valley	—	—	—
St. Louis	17	21	19
San Diego	11	8	13
San Joaquin	—	—	—
Savannah	—	—	—
Shreveport	20	17	15
South Carolina	17	20	—
South Florida	11	8	13
South Piedmont	—	—	—
Southern Alberta	18	15	20
Southern California	10	14	12
Southern Connecticut	13	10	—
Toledo	3	7	5
Tucson	4	8	6
Utah	—	—	—
West Texas	28	25	—
Western Massachusetts	20	17	—
Western Michigan	10	14	12
Wichita	17	21	19
Wisconsin	17	21	—



Round blue spot shows the system is full and dry.

Round pink spot shows that moisture is present.

Color spot indicator loses its shape when refrigerant level drops.

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This dual-purpose indicator gives the same dependable, leak-proof performance that has made the Streamline single port liquid indicators famous for years but has the added advantage of being a combination moisture and liquid indicator all in one compact unit. A color spot indicator in the new Vuemaster makes possible an instant check of the refrigerant. When the color spot is round and blue, the system is sufficiently charged and the refrigerant is in a normal, dry condition. The spot changes to pink when excessive moisture is present and loses shape when refrigerant supply is low.

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(*Continued from page 77*)

prietary borate-nitrate-nitrite inhibitor was added to the other.

Incipient corrosion was visible within 24 hr in the chromate treated storage box while the tubes in the borate-nitrate-nitrite treated test did not corrode. Fig. 7 shows the corroded condition of the tubes from the two boxes after 3 months test time. The large localized pitted areas located on the tubes from the chromate treated storage box were covered with large carbuncles before cleaning. When analyzed spectrographically, the material in the carbuncle consisted of iron and chromium, presumably in the oxide or hydrated oxide form. The material was not crystallized well enough for identification by X-ray diffraction. Table IX shows the water analyses carried out each test. Little evaporation took place in the chromate treated box since chemical concentrations remained approximately the same.

Tests investigating the variables associated with the preceding, attempting to find the cause of localized attack in the chromate treated storage test included studies of stray current effects associated with a nearby motor-generator set, the addition of another salt (Na_2SO_4) for buffering effect, the initial boiling after inhibitor addition to promote protective film formation. The tests showed that none of these variables had any effect on localized corrosion.

The remaining variable was the chloride concentration in the test water. Another series of tests was made using varying chloride concentrations: 34 ppm for test book No. 1, 73 ppm for test box No. 2, and 140 ppm for test box No. 3. Large carbuncles formed on the tubes and tube-tube sheet junctions of the test box containing 140 ppm chloride within 48 hr. (Fig. 8)

Literature[5] indicated that the sulfate concentration would have the same effect on the sodium nitrite inhibitor as chloride on the chromate inhibitor. Tests to determine the concentrations of sulfate which would reduce the effectiveness of a sodium borate-sodium nitrite mixture at a nominal concentration of 2500 ppm (Table IX) were devised.

The results showed that the sulfate ion would interfere with the inhibitive properties of the sodium nitrite inhibitor. More than 500 ppm of sulfate concentrations were required to produce corrosion at nominal inhibitor concentration (2500 ppm). The type of attack differed from that of chloride on the chromate inhibitor (Fig. 9). In the case of the sulfate interference with the nitrite inhibitor properties, the attack was more general than localized.

Further testing with the borate-nitrate-nitrite inhibitor (nominal 3000 ppm concentration, Test 20-22) showed a similar corrosion occurring at approximately 200 ppm concentration of sulfate ion ($SO_4=$). Since sodium nitrite makes up approximately 30% of this inhibitor compound, it appears that if the sodium nitrite concentration is less than four times the sulfate concentration, proper storage inhibition is not attained under these test conditions.

TABLE VIII

TUBE METAL ANALYSIS—STORAGE TESTS

Description	Tubes Used in the Oxygen Corrosion Demonstration Test	Tubes Used in Chromate and Borate-Nitrate Nitrite Test	Tubes Used in Evaluating Chromate-Chloride Relationship
Carbon, as C	0.12	0.10	0.13
Silicon, as Si	<0.01	0.01	<0.01
Manganese, as Mn	0.40	0.45	0.45
Phorphorus, as P	0.014	0.012	0.010
Sulfur, as S	0.046	0.032	0.029
Nickel, as Ni	0.045*	0.10*	0.04*
Chromium, as Cr	Not Detected	0.05*	0.023*
Vanadium, as V	"	—	0.012*
Molybdenum, as Mo	0.008*	0.015*	0.010*
Copper, as Cu	0.055*	0.037*	0.076*
Aluminum, as Al	0.003	0.014*	0.007*

* Spectrographic analyses

CONCLUSIONS

Tests conducted since April, 1957, have resulted in the following conclusions:

1 – The Steel Boiler Institute buffered chromate inhibitor at a nominal concentration of 2200 ppm is satisfactory in preventing dissolved oxygen corrosion of plain carbon steel tubing when hardness in the boiler water is present.

2 – Both the proprietory borate-nitrate-nitrite inhibitor at a concentration of 3000 ppm and the borate-nitrite (10% sodium borate, 90% sodium nitrite) mixture (at 2500 ppm) are also satisfactory in preventing dissolved oxygen attack on plain carbon steel tubing. These inhibitors were tested with and without hardness in the boiler water.

3 – The "soluble oil" inhibitor was not a satisfactory inhibitor under test conditions. Considerable pitting and corrosion of the tubing as well as a serious foaming condition, resulting in boiler water carryover into the stream occurred. Under boiling conditions the soluble oil emulsion partly broke down as exhibited by oil in the boiler gauge glass.

4 – A confirmation test with sodium hydroxide as an inhibitor in oxygenated-distilled boiler water containing sodium chloride, showed the ineffectiveness of this chemical compound (alone) in new plain carbon steel tubing.

5 – An additional "high strength, low alloy" tube material and a copper bearing steel were tested in oxygenated-distilled boiler water containing sodium chloride. Neither alloy (Table II and III) had markedly less pitting than plain carbon steel. It appears that low alloy steels of this type will not provide a satisfactory solution to the tube corrosion problem.

6 – Copper flash-plating of plain carbon steel boiler tubes with acidic copper sulfate and its subsequent operation in oxygenated distilled boiler water containing sodium chloride did not lead to accelerated corrosion. Copper in the form of copper sulfate was added to the boiler water, periodically.

7 – Sodium nitrite, alone, was an effective inhibitor in oxygenated-chloride containing boiler water. However, sodium nitrite should not be used without a

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chemical buffer to produce an alkaline pH.

8 – In tests reported here, the Steel Boiler Institute buffered chromate inhibitor at a nominal 2200 ppm concentration was a satisfactory wet storage inhibitor under atmospheric conditions, provided that the chloride concentration in the water was not more than 100 ppm. Storage tests were conducted with chloride concentrations only 73 ppm and 140 ppm; however, the accelerated test boilers, using the SBI chromate compound, were operated at the 100 ppm chloride (nominal) level, and down-time storage during test periods occurred without adverse effects. Most original fill waters will be below this chloride figure and with no, or quite small, losses of steam or water from the system, thus avoiding concentration of boiler water salts. However, this difficulty with the SBI chromate should not be a serious problem.

9 – Borate-nitrite at a nominal 2500 ppm and proprietary borate-nitrate-nitrite at 3000 ppm were satisfactory atmospheric wet storage inhibitors. Chloride at concentrations to 300 ppm does not interfere, but high sulfate concentrations in the water would interfere with the effectiveness of these inhibitors under the test conditions used. A sulfate concentration of at least 500 ppm at the nominal borate-nitrite inhibitor concentration of 2500 ppm was necessary. Natural waters containing this high concentration of sulfate are unusual. However, it was found that the nitrite and sulfate concentrations were related. The sodium nitrite concentration should be at least four times the sulfate concentration for storage protection, emphasizing the importance of low system losses.

Recommendations – If adhered to, the following should produce a general increase in the operating reliability of low-pressure steam (15 psig max) boilers.

1 – The watersides of all new boilers should be cleaned by boiling it out with a 0.5% solution (approx. 4 oz/5 gal water) of soda ash (Na_2CO_3 n H_2O), then by draining and rinsing it with fresh water.

2 – The boiler should be refilled with water and the proper chemical inhibitor added. It should then be fired for a short period to insure proper dissolution and mixture of the inhibitor in the water. Never permit a boiler to stand in wet storage without a proper chemical inhibitor in the boiler water. Choose an inhibitor from the following:

Steel Boiler Institute chromate inhibitor at a concentration of 1.5 oz per five gal of water. If the boiler water contains more than 100 ppm (approx. 6 grains/gal) chloride, wet storage tests show that severe localized corrosion occurs.*

A borate-nitrate-nitrite inhibitor (approx. 40% sodium borate (borax), 30% sodium nitrite and 30% sodium nitrate) at a concen-

TABLE IX
WET STORAGE TESTS

Test No.	Test Conditions	Length of Test Hours	Inhibitor**	Inhibitor Conc. ppm Initial	Inhibitor Conc. ppm Final*	Chloride ppm Initial	Chloride ppm Final*	Sulfate ppm Initial	Sulfate ppm Final*	Dissolved Oxygen mls/liter	pH	Comments
1	Test box stored open to atmosphere.	2713	None	—	—		216	None	—	(1)	6.6	Severe corrosion.
2	Deaerated and stored under nitrogen.	2713	None	—	—		214	None	—	0.07	9.2	No corrosion.
3	Test box stored open to atmospheric conditions.	2328	A	2000	1977	324	336	None	—	(2)	9.5	Large carbuncles. Pit corrosion under
4	Same as 3.	2328	B	3000	4350	306	340	None	—	(2)	9.2	carbuncles.
5	Boiled and allowed to cool to room temperature. Stored open to atmosphere.	1656	A	2000	2644	300	348	None	—	(2)	9.2	No corrosion. Same results as test 3.
6	Grounded by copper wire to nearby motor generator set. Stored open to atmospheric conditions.	1656	A	2000	2059	280	284	None	—	(2)	9.4	See test 3.
7	Same as 3.	1656	A	2000	1983	254	260	None	—	(2)	9.2	See test 3.
8	Same as 3.	2568	A	2000	2682	None	None	None	—	(2)	8.0	No corrosion.
9	Same as 3.	2568	A	2000	3369	128	172	None		(2)	8.6	See test 3.
10	Same as 3.	2568	A	2000	4100	240	346	None	—	(2)	8.6	See test 3.
11	Same as 3.	1320	A	2308	2721	29	34	None	—	(2)	8.1	No corrosion.
12	Same as 3.	1320	A	2472	3440	62	73	None	—	(2)	8.1	No corrosion.
13	Same as 3.	1320	A	2103	3660	114	134	115	140	(2)	8.4	Large carbuncles formed within 48 hr of test start.
14	Same as 3.	768	C	2490	2499	None	None	60	55	(2)		No corrosion.
15	Same as 3.	768	C	2531	2620	None	None	140	150	(2)		No corrosion.
16	Same as 3.	768	C	2508	2600	None	None	275	230	(2)		Possible incipient corrosion.
17	Same as 3.	1632	C	2728	2650	None	None	540	575	(2)		No corrosion.
18	Same as 3.	1632	C	2510	2575	None	None	705	705	(2)		Severely corroded.
19	Same as 3.	1632	C	2518	2669	None	None	980	1050	(2)		Severely corroded.
20	Same as 3.	168	B	3125	—	—	—	525	—	(2)		Severe corrosion.
21	Same as 3.	168	B	2995	—	—	—	260	—	(2)		Slight corrosion.
22	Same as 3.	168	B	3400	—	—	—	175	—	(2)		No corrosion.

* Concentration of chemicals due to natural evaporation of water in test boxes.
** Inhibitor A-SBI chromate.
Inhibitor B-Borate-nitrate-nitrite.
Inhibitor C-Borate-nitrite.
[1] No determination due to large amounts of dissolved and precipitated iron. Solution was reducing due to dissolved ferrous iron.
[2] Water exposed to laboratory atmosphere and therefore assumed to be saturated (6 mls/liter O_2) room temperature.

tration of 2 oz per five gal of water. *If the boiler water contains less than four times as much sodium nitrite as sulfate, wet storage tests show that corrosion occurs. (This would be equivalent to approx. 30 grains/gal for the borate-nitrite or 12 grains/gal for borate-nitrate-nitrite inhibitor).

A borate-nitrite mixture (90% sodium nitrite and 10% sodium borate) at a concentration of 1.7 oz per five gal of water. Also the note concerning sulfate concentration effects applies to this inhibitor.

3 – It is recommended that prior to summer or other wet-storage periods the boiler be drained and refilled, in view of the possible concentration of undesirable anions, such as sulfate and chloride in the boiler water due to make-up for steam losses and system leaks during the heating season. After draining and then refilling with fresh water, the proper concentration of the desired inhibitor should be added and the boiler fired for a short period to insure proper solution and mixture of the inhibitor in the boiler water before leaving out of service.

During this short firing period, air must be steamed out of the system through the vents and the boiler then shut-down and sealed for storage. The boiler must not be allowed to stand after draining and refilling, unless it's fired to drive off dissolved oxygen.

4 – Tests show that these inhibitors, when used in specified amounts, stopped corrosion which was already in progress. But due to the uncertainty of what amount and type of waterside deposit accumulations may be present in old units, depending on local conditions, cleaning these boilers before adding the proper chemical inhibitor is recommended. Chemical cleaning agents and inhibitors can be used. (The boiler owner should contact his local plumbing and heating service.)

* Refer to conclusions numbers 8 and 9 in preceding text.

ACKNOWLEDGMENTS

This research was carried out at the Research Center of The Babcock & Wilcox Co. Tubular Products Division, for the Steel Boiler Institute. The guidance of the Engineering Committee of the SBI is gratefully acknowledged. Appreciation is also extended for the help provided the writers by H. F. Hinst, Chief Metallurgist, Keystone Plant of the Tubular Products Division of the Babcock & Wilcox Co.

BIBLIOGRAPHY

(1) Keilbaugh, W. A. and Pocock, F. J. Corrosion Inhibition on Tubes in Low Pressure Steel Boilers, *Heating, Piping and Air Conditioning*, February, 1958.
(2) Butler, G. M. A., Ison, H. C. K., Model Boiler Tests on the Influence of the Copper Content of Steel on the Corrosion of Tubes in Artificial Sea Water. *The Institute of Marine Engineers*. Feb. 12, 1957.
(3) Robertson, W. D., *Molybdate and Tungstate as Corrosion Inhibitors and the Mechanisms of Inhibition*. Journal of The Electrochemical Society, Vol. 98 No. 3, 1951.
(4) Manual on Industrial Water, ASTM Committee D-19, ASTM Special Publication No. 148, American Society of Testing Materials, Phila., Penna.
(5) Sussman, Sidney, et al. Experiences with Sodium Nitrite Unpredictable Corrosion Inhibitor, Industrial and Engineering Chemistry, Vol. 51, No. 4, pp. 581-584, April, 1959.

COOLING LOADS

(*Continued from page* 49)

value of 4120 for the first level gives 3530 Btu/hr, which is in good agreement with the measured load on the level.

Applying the proposed factors to the I-B-R Research Home resulted in calculated sensible heat gains which were in excess of those calculated by either Manual 11 or Guide C-30 while the measured sensible heat gain was less than any of the calculated values. It is true that this home was extremely well shaded by trees and nearby buildings. Correcting the calculated glass gains for the natural shading which existed reduced the calculated sensible heat gain when using the proposed factors from 16,830 to 14,170 Btu/hr as compared to a measured heat gain of 11,077 Btu/hr. There is no doubt but that the shading also reduced the heat gain through the roof and the walls; furthermore, the windows had shades half drawn in addition to draperies. The glass factors used assumed the use of draperies but did not consider the combined effect of shades and draperies. In all probability these additional shade effects on glass, walls, and roof caused the difference between the measured and calculated loads.

CONCLUSION

At the request of the industry, a joint committee composed of trade association representatives appointed a study group to review the existing residential cooling load estimation procedures with the objective of developing an estimation method acceptable to the entire industry. The study group analyzed ASHRAE GUIDE information on heat gains and also the cooling loads measured in 5 research houses located at the University of Illinois. From the review and analysis, a cooling load estimation method has been proposed which when applied to the 5 research houses has resulted in an estimated load that closely approximates the measured maximum load in each of the houses. Such agreement has not been achieved through the application of any of the existing methods. That is, loads for the same houses estimated by existing methods have been in good agreement in some but not all cases. Since the 5 houses represent a wide variety of constructions, it is believed that the proposed method is applicable to any house of contemporary design.

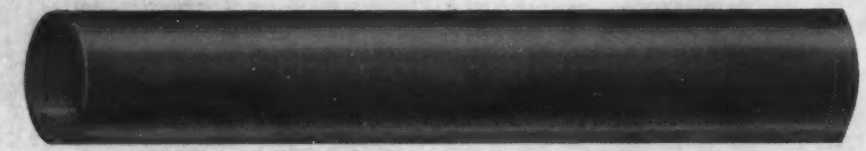
ACKNOWLEDGMENT

The advice and comments of F. J. Reed, Air Conditioning and Refrigeration Institute; J. I. Woodworth, Institute of Boiler and Radiator Manufacturers; H. T. Gilkey, National Warm Air Heating and Air Conditioning Association; G. R. Munger, Owens-Corning Fiberglas Corporation; and F. H. McGhan, Federal Housing Administration, are gratefully acknowledged.

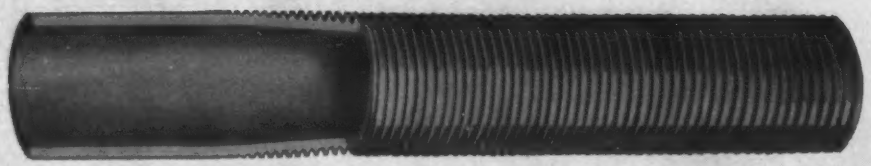
REFERENCES

1. "Cooling Studies in a Research Home", W. S. Harris and P. J. Waibler. (ASHVE TRANSACTIONS, Vol. 60, 1954, p. 487.)
2. "Performance of a Hot Water Heating System in the Research Home", A. P. Kratz, M. K. Fahnestock, W. S. Harris and R. J. Martin. ASHVE Journal Section, Heating Piping and Air Conditioning, December, 1941.
3. "Cooling a Small Residence with a Two-Horsepower Mechanical Condensing Unit", H. T. Gilkey, D. R. Bahnfleth and R. W. Roose. (ASHVE TRANSACTIONS, Vol. 59, 1953, p. 473).
4. "Effects of Weather Conditions on Cooling Unit Operation in a Residence", H. T. Gilkey, W. F. Stoecker and S. Konzo.

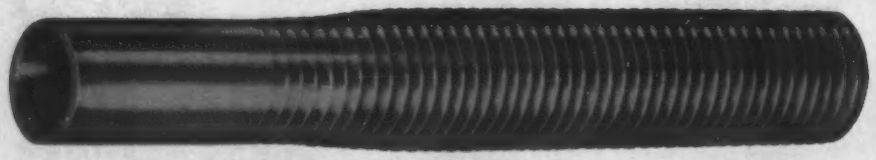
Wolverine Tube manufactures the industry's most complete line of tube for heat transfer



PRIME SURFACE TUBE



WOLVERINE TRUFIN TYPE S/T



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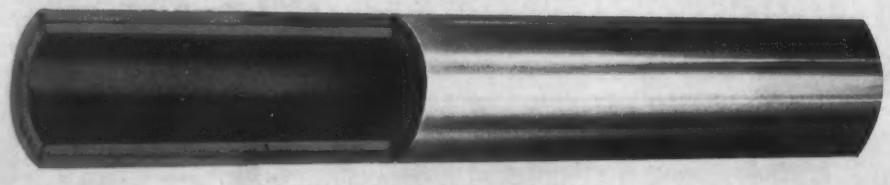
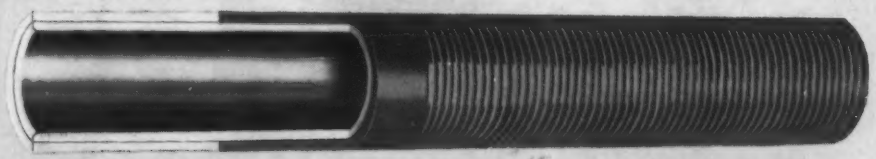


DUPLEX PRIME SURFACE TUBE



DUPLEX WOLVERINE TRUFIN, TYPE S/T

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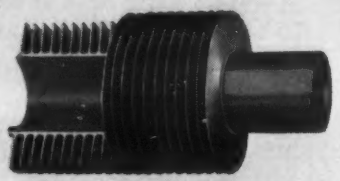

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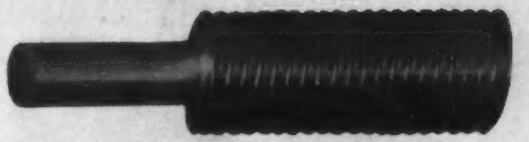

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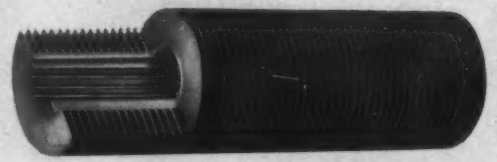

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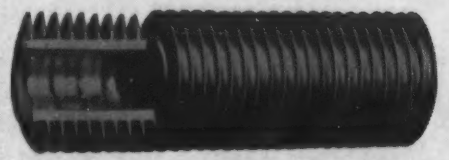

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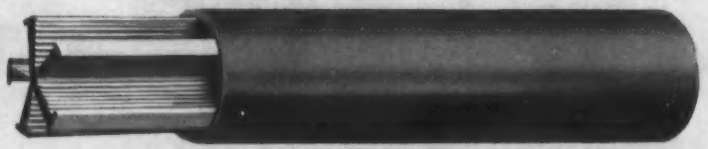

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PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
SALES OFFICES IN PRINCIPAL CITIES

(ASHAE TRANSACTIONS, Vol. 61, 1955, p. 259.)

5. "Cooling a Small Residence Using a Perimeter-Loop Duct System", D. R. Bahnfleth, C. F. Chen and H. T. Gilkey. (ASHVE TRANSACTIONS, Vol. 60, 1954, p. 271.)

6. "Measurement of Infiltration in Two Residences", D. R. Bahnfleth, T. D. Moseley and W. S. Harris. (ASHAE TRANSACTIONS, Vol. 63, 1957. Part I, p. 439, Part II, p. 455.)

7. *Manual No. 11*, "Design and Installation of Summer Air Conditioning for New and Existing Residences", 4th ed. (National Warm Air Heating and Air Conditioning Association, Cleveland, 1959.)

8. *Guide C-30*, "I-B-R Cooling Load Calculation Guide", 1st ed. (The Institute of Boiler and Radiator Manufacturers, New York, 1956.)

9. *Year-Round Residential Air-Conditioning*, "Standard 230-57," (Air-Conditioning and Refrigeration Institute, Washington, D. C., 1957.)

SMOOTH DUCTS

(*Continued from page 67*)

the pressure loss so that the reduced loss is to be credited both to the type of joint and the smoother and longer asbestos-cement ducts. Asbestos-cement duct joints with outside connections, such as an outside sleeve or a taped joint in which there is no obstruction of flow within, will result in the reported 30% figure. Based on the original data of the 6 and 8-in. sizes, pressure loss for sizes 3, 4, 5, 7, 10 and 12-in. were extrapolated (Fig. 4).

Professor A. J. DelMastro of Rutgers University, as an independent professional engineer, witnessed and verified these test runs at our Research Center.

BIBLIOGRAPHY

1—A. B. Algren and L. M. Fingerson: "An Investigation of Friction and Dynamic Losses on Duct Capacities of Small Diameter Ducts." (University of Minnesota, 1955.)

2—HEATING VENTILATING AIR CONDITIONING GUIDE, American Society of Heating, Refrigerating and Air Conditioning Engineers, 1960.

3—"Warm Air Perimeter Heating" (National Warm Air Heating and Air Conditioning Association Manual 4, sixth edition, 1959.)

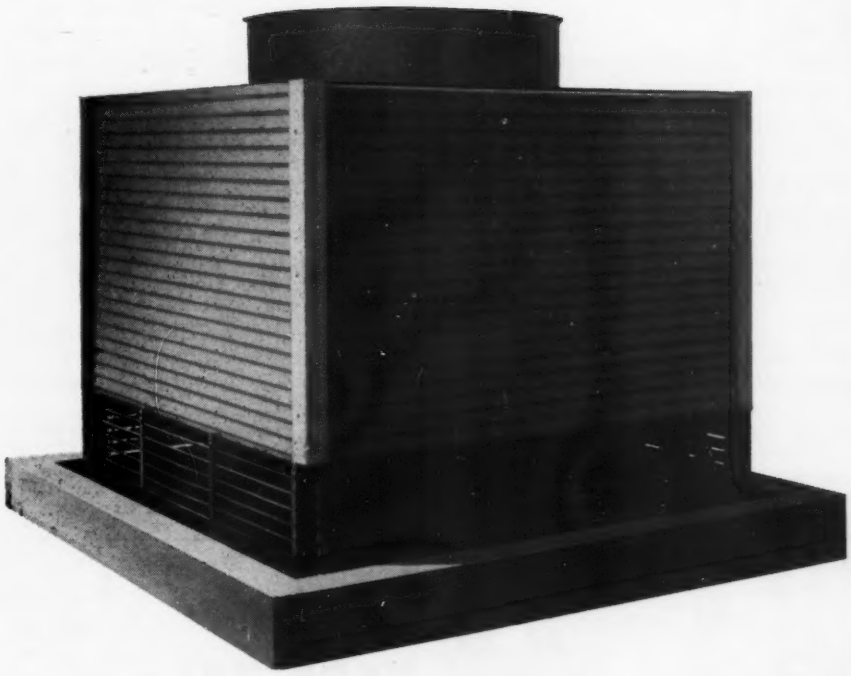
BULLETINS

Pressure Reducing Valve. Capacity of 50,000 lb of steam per hr or 2500 gpm of water is announced for this sliding gate and plate pressure reducing valve. Air-operated, the unit is available in four and six-in. sizes, and is suitable for pressures to 250 psi and temperatures to 500 F. Flyer SRBc 16-60 describes features, lists components and gives start-up and adjustment instructions.
OPW-Jordan Corporation, 6013 Wiehe Rd., Cincinnati 13, Ohio.

Air Mixing Units. Certified sound data for dual duct mixing units is offered in Flyer E-29. Units were tested mixing air in volumes ranging from 200 to 800 cfm, with readings taken

(*Continued on page 114*)

FLUOR COOLING TOWERS



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NEW PRODUCTS

(*Continued from page* 100)

tivity down to zero to ten micron full scale (0.00039 in.). In every range, internal calibration is available, permitting calibration of meter and transducer to a high degree of precision. A special terminal for connecting output of the meter into an oscilloscope or high speed recorder is provided for making permanent records.
Korfund Company, Inc., Cantiague Rd., Westbury, N. Y.

BASEBOARD HEATERS

Installed ankle-high at room perimeters to offset heat loss and maintain temperatures, these new forced hot water baseboard heating units have no grilles. Air enters a continuous opening at the floor line, passes over the heating element and flows out through a continuous opening at the top. All elements are completely enclosed.

Additionally, air warms the metal face of the baseboard itself, forming a continuous radiant panel. By natural convection, the heated air blankets exposed walls and window area and direct radiant heat from the unit adds warmth to floor and lower portions of the room. Two standard sizes are available, 9½ in. high by 2⅞ in. deep and 11¾ in. high by 3-3/16 in. deep.
Modine Manufacturing Company, 1500 DeKoven Ave., Racine, Wisc.

CANDIDATES FOR MEMBERSHIP

(*Continued from page* 88)

ZASLER, M. S., Design Engr., Victor Gruen, Beverly Hills.

Oregon

HABEL, H. B., Sales Engr., Arrow-Hart & Hegeman Elec., Portland.

FOREIGN

Arabia

CHOWDHURY, S. H., Designer, A-C. Htg. Vtg. Design Section, Dept. of Electricity, Government of Kuwait, Kuwait.

Italy

ARIATTA, PIERO, Cons. Engr., Milan.
BARBARO, DOMENICO, Engr., Instituto Fisica Tecnica, Palermo.
BARBERIS, ALDO, Gen. Mgr., Eredi Traschetti, Torino.
BOTTACIN, RENZO, Mgr. & Owner, Giuseppe Bottacin, Padoa.
BOZINO, R. A., Co-owner, Bozino & Co., Milan.
CECCATELLI, MARIO, Chief Engr. A-C., Barbieri C. M., Bologna.
CREMASCHI, ALBERTO, Co-Owner, M.I.T.A. s.a.s., Milan.

New Zealand

RIKKER, LOUIS, Design Draftsman, Heat & Air Control Ltd., Auckland.
TAYLOR, L. F.,† Mgr., Refr. & A-C. Div., Jas. J. Niven & Co. Ltd., Auckland.

Okinawa

KWAN, SENG,* Actg. Mgr. & Chief Engr., American Engineering Corp., Naha.

Yugoslavia

BRLEK, VELJKO, University Teacher, Machine & Shipbuilding Faculty of University of Zagreb, Zagreb.

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CARLTON, A. H., Auburn University, Auburn, Ala.
CORLES, M. E., Auburn University, Auburn, Ala.
FOSTER, C. B., Auburn University, Auburn, Ala.
HONG, C. S., Auburn University, Auburn, Ala.
SHELTON, J. K., Auburn University, Auburn, Ala.

ASHRAE 1960 TRANSACTIONS

Following precedent volumes and 6 x 9 in., cloth bound, ASHRAE TRANSACTIONS covering 1960 will go to press shortly.

Included will be the full record of Society events, the Semiannual Meeting in Dallas, the Annual Meeting in Vancouver (including technical papers presented at both National Meetings and discussions upon them), listings of national officers and committees, records of Chapter personnel and other established features.

As directed by the ASHRAE Executive Committee, the 1960 TRANSACTIONS will be issued in but a limited quantity and will be priced at $3.00. Previously, this book was distributed to Society members, upon specific request, without charge. Thus, those wishing to obtain a copy of the 1960 TRANSACTIONS are requested to return the form shown below.

Name .....

Address .....

I wish to have a copy of the ASHRAE 1960 TRANSACTIONS. You may bill me $3.00.

Signature .....

Applications

CREATIVE ARTS BUILDING GETS CONTROLLED CLIMATE

Located in the warm climate of the San Francisco Bay area, the new Creative Arts Building of Pittsburg, Calif., High School required incorporation of year-round air conditioning into the building design. Zone control was necessitated by varying temperature conditions in the building's auditorium and by diversity of building usage. Selected for the system were a hermetically sealed centrifugal water chiller and cast iron hot water boilers.

To generate chilled water through a central air conditioning plant and remote equipment rooms for cooling and dehumidification, as required, a 125-hp Trane Hermatic CenTraVac was installed. For winter heating and reheat as required during the cooling season, a large cast iron boiler approved for 80 psi working pressure will generate hot water. Installed in the central mechanical equipment room, a graphic supervisory data center indicates dry bulb temperatures throughout the various zones and certain critical points in the system. This center automatically programs the chilled and hot water plants as dictated by zone thermostats and humidistats throughout the building.

Chilled water is circulated in a closed loop in the chiller room by a central pump. For each conditioning unit, an individual circulating pump draws water as required from this loop and delivers chilled water blended with by-pass water to its zone cooling coil. Water from the coils is either returned to the CenTraVac for recooling or bypassed through a three-way blending valve. Reheat is provided by a hot water coil downstream from the cooling coil. Winter heating is provided in a similar manner to cooling—constant water volume through the heating coil, using a separate circulator for each zone.

HANGAR DOOR HEATER FACILITATES WINTER FLIGHTS

To prevent frozen hangar doors, a completely packaged electric heating unit was installed on the hangar used by American Can Company at Westchester County Airport. Manufactured by Hynes Electric Heating Company, the heater is a 48-kw, 160,000-Btu/hr fluid heat transfer unit connecting with pipelines embedded in concrete just under hangar door rails. Four lines of 1½-in. Schedule 40 steel pipe beneath the rails form a pipe coil through which oil at 85 F is circulated.

An electric heating unit was chosen in preference to oil-fired equipment because of compactness, safety and ease of installation. Heater is used only when icing conditions are prevalent or expected, and is started manually several hours in advance of the expected arrival of bad weather.

TWO-PART SYSTEM TO CONDITION SYRACUSE APARTMENT BUILDING

To prevent seepage of air from living spaces along corridors, a two-part system will be installed in Imperial Gardens, a fully air conditioned apartment building under construction in Syracuse, N. Y. One half of the system will supply conditioned outside air to apartments and hallways from central apparatus in the basement. Air sent into the apartments will equal that removed through fan-driven exhausts located in kitchens and lavatories. In the other half of the system, 375 Carrier fan-coil units located under windows will maintain comfortable temperature and humidity levels in the 115 apartments. Each unit can be controlled individually by the tenant. Two hot water boilers and a Carrier water chilling machine with cooling capacity of 250 ton will be in the basement.

CHAPTERS REGIONAL COMMITTEE

MEETINGS AHEAD

REGION I, Boston Chapter (Boston), Oct. 10-11
REGION III, Richmond Chapter (Williamsburg), Oct. 19-20
REGION IV, Atlanta Chapter (Atlanta), Oct. 19-20
REGION V, Central Indiana Chapter (Indianapolis), Oct. 24
REGION VI, Iowa Chapter (Des Moines), Nov. 2
REGION VII, Kansas City Chapter (Kansas City), Nov. 3

BULLETINS

(*Continued from page* 110)

from units discharging air directly into a 7 x 11-ft test room with no ductwork or outlets to provide additional attenuation.
Buensod-Stacey, Inc., 45 W. 18th St., New York 11, N. Y.

Steam Traps. Diagrammatic drawings show operational characteristics, design, materials used and construction of four styles of thermostatic radiator traps: corner, straightway, vertical and angle; and eight models of float and thermostatic traps, including Model 69B which, because it has two inlets and two outlets, can be installed in any one of four operating positions. Roughing in dimensions and capacity tables for all models are shown. Incorporated in this four-page bulletin are two others: No. 102, Thermostatic Radiator Traps, and No. 202, Float and Thermostatic Traps.
Sterling, Inc., 5200 W. Clinton Ave., Milwaukee 23, Wisc.

Pump Catalog. Covered in 32-page Catalog 460 are rotary positive, four-wing type double and single – cylinder, two-wing type, high vacuum, automatically controlled, rotary oil-less, integral air and vacuum and motor-driven pumps; air motors; gas boosters, oiling systems; filters; and separators. Specifications, dimensions and diagrammatic illustrations are included, as well as a separate section on engineering data.
Leiman Bros., Inc., P. O. Box 1339, Newark 1, N. J.

Air Handling Units. Available at ratings from 400 to 30,000 cfm for cooling, heating, ventilating, humidifying, dehumidifying, filtering and air conditioning, Centralaire air handling units are the subject of 16-page Bulletin 404. Extensive specifications and engineering information are included.
Airtherm Manufacturing Company, Heating & Air Conditioning Div, P. O. Box 7039, St. Louis 77, Mo.

Water Conditioning Manual. How to secure clear, non-corrosive, non-clogging, non-precipitating water for commercial, industrial and home use is described in 24-page Bulletin MA-DP-10M-7-60, "Water Conditioning with Karlsonite for Preventive Maintenance." Use of chemicals as water conditioners for cooling towers, evaporative condensers, water-cooled equipment and other applications is covered in detail. Water testing instructions, installation procedures and water data and conversion tables are also included.
Stiles-Karlsonite Corporation, 1550 Grand Ave., Waukegan, Ill.

Heaters. Plant heating problems in the metalworking industry and solutions offered by overhead recirculating, fresh air supply and door heaters are discussed in four-page Bulletin MI-60. Covered are problems of proper warm air distribution in areas full of machinery or stocks of raw materials, replacement of air exhausted by fume removal systems and tempering of cold air inrush through shipping doors. Diagrams and photographs illustrate applications.
L. J. Wing Manufacturing Company Div, Aero Supply Manufacturing Company, Inc., 140 Vreeland Mills Rd., Linden, N. J.

Nylon Hose Fittings and Assemblies. Four-page Bulletin BR-3HF on Nylaflow nylon pressure hose contains a hose selector and data on an extensive range of re-usable fittings. Instructions for applying fittings and information on ordering assemblies are included. Hose is available in burst pressure ratings of 5000 and 8000 psi with inside diam from ⅛ to ½ in.
Polymer Corporation of Pennsylvania, 2140 Fairmont Ave., Reading, Pa.

Cooling Controls. Bulletin 1487-AN, on mechanical cooling and air conditioning controls, includes a line of coded control centers for air conditioning and several new items listed for the first time. Fan centers, cooling centers and system centers are catalogued and all-range water valves, Series 246, are shown from ⅜ through 1½-in sizes.
Penn Controls, Inc., Goshen, Ind.

Steam Converter Catalog. Descriptive of a new line of steam converters for heating radiation water with steam, 22-page Catalog 1460 indicates advantages of these units in such applications as large installations when zoning is desirable and steam as the source of heat may simplify piping design and reduce design work required for exclusive use of water. Included in the catalog are specifications, operation data, leaving water tables from 170 through 230 F, piping installation diagram and water side pressure drop curves.
Dunham-Bush, Inc., 179 South St., West Hartford 10, Conn.

Registers, Grilles, Diffusers. 72-page Catalog 60-AC utilizes a color-coding arrangement so that data on any individual product in the air control line can be obtained easily. Pertinent information, including unit illustrations, specifications, capacities, selection charts, dimensions, installation diagrams and instructions, is offered for an extensive line of registers, grilles, diffusers and self-drilling and sheet metal (tapping) screws.
Air Control Products, Inc., Coopersville, Mich.

Valves and Accessories. Descriptive of more than 100 different types of shut-off, pressure relief and flow check valves, driers, filter-driers, strainers, liquid gauges, flanged unions, liquid indicators and moisture-liquid indicators, 20-page Catalog No. 104 contains extensive engineering information. Several pages of the booklet discuss filter-driers which feature a combination of granular desiccant and molded core to provide two-stage drying and acid removal with progressive filtration.
Henry Valve Company, 3215 North Ave., Melrose Park, Ill.

Ice Flake Machine. Two models available, a ¼-hp hermetic condensing unit with a capacity of 250 lb of ice flakes in 24 hr and a 1/3-hp unit with a capacity of 300 lb, are discussed in a four-page bulletin. Featured on both models is an ice auger, set in an evaporator of wrapped-coil construction designed to obtain max freezing. The entire auger assembly may be lifted out of the machine in seconds and completely disassembled, for ease of cleaning and servicing.
Freez King Corporation, 2518 W. Montrose Ave., Chicago 18, Ill.

Duct Furnaces. Installation of duct furnaces downstream of cooling surface in air conditioning systems is cited as being practical with this new line of furnaces, when equipped with optional stainless steel drain pan. Built-in by-pass offered as standard equipment eliminates need for addition of a separate by-pass duct to handle the greater cfm required by systems which provide cooling. Offered in six sizes ranging from 75,000 to 300,000 Btu/hr input, all models are AGA approved for use on natural mixed or LP gases. Controls are designed for 24-volt service and can be converted to 115 and 230-volt operation by means of a transformer. Six-page Bulletin 659-B describes and illustrates the new line, giving extensive specification and performance data.
Modine Manufacturing Company, 1500 DeKoven Ave., Racine, Wisc.

CLASSIFIED ADVERTISING

RATES—Classified advertisements at this heading are inserted in 8-point type at the rate of $1.00 per line or fraction thereof, including heading and address. Eight words to the line average. Box number address counts as one line. Minimum insertion charge, 5-line basis. Maximum insertion 10 lines. Prices are net, no discounts. Box number replies promptly forwarded without charge. Available Engineers insertions up to 60 words for Full and Associate members, and Affiliates are carried free.

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Address classified advertising or requests for further information to ASHRAE JOURNAL 62 Worth St., New York 13, N. Y.

OPENINGS

MECHANICAL ENGINEER—Air Conditioning. $7,800 per annum New York City Civil Service. Requirement, resident NYC 3 yr. Write or apply in person to Dept. of Personnel, 96 Duane St., NYC, between Oct. 5 and Oct. 25.

REFRIGERATION APPLICATION ENGINEERS wanted. Expansion has created openings for engineers. Experience in design of refrigeration systems. Also creative application and component design required. BSME degree or equivalent desired. Submit resumes and salary requirements to: A. W. Bell, Director Industrial Relations, Frick Co., Waynesboro, Pa.

DESIGN ENGINEER—Expansion has created openings. 5-10 yr experience with reciprocating and rotary compressors required. Capable of making original designs. Leads to staff position. Submit resume and salary requirements to: A. W. Bell, Director Industrial Relations, Frick Co., Waynesboro, Pa.

HEATING-VENTILATING ENGINEER—4 yr apprenticeship, 3 yr experience in Zurich (Switzerland). Will emigrate. 2 yr experience in London. Looking for position in consulting or contractor firm. Will locate anywhere. Complete resume on request. Box 103, ASHRAE JOURNAL.

CHIEF ENGINEER—wanted by cold storage warehousing and ice company with multi-plant operation. Want college graduate with 10 yr practical experience who can take complete charge of refrigerating, construction, and maintenance of company properties. Must have previous experience in ammonia systems, know all major lines of refrigeration equipment, and be able to design layout, and redesign both new and existing refrigeration systems in ice plants and cold storage warehouses. Must have prior supervisory experience, able to work maintenance and construction crews and engineers. Travel. Salary open. Age to 45. Send resume to Box 108, ASHRAE JOURNAL.

SALES ENGINEER-EXECUTIVE—Outstanding opportunity for aggressive, experienced, sales-minded engineer with management qualities. Engineering contracting firm, specializing in high velocity systems, requires high caliber man to head operations in the New York area. Send resume to Box 111, ASHRAE JOURNAL.

ENGINEER ESTIMATOR—Young aggressive company needs man capable of estimating and bidding from plans and specifications, plumbing, heating, sheet metal and air conditioning jobs. Must be capable of layout and design of mechanical work, and capable of dealing with the public, and negotiating contracts and change orders. Good salary and stock purchase option available for right man. Box 104, ASHRAE JOURNAL.

ENGINEERING, PRODUCT DIVISION—or General Manager. Thoroughly experienced and competent to direct the development, manufacture and application of major products of refrigeration and air conditioning in-

HOUSEHOLD REFRIGERATION
a proposed ASHRAE Bulletin

To make available generally the full text of Chapter 57, as prepared originally for the 1961 ASHRAE GUIDE AND DATA BOOK but subsequently reduced considerably in length for actual publication therein, there is planned tentatively an ASHRAE 40-page Bulletin.

This will include not only the original full text for Chapter 57 but a 10-page reference to Thermoelectricity as applicable to refrigeration practice.

Authoritative, detailed and following GUIDE form, including illustrative material, this Bulletin has been authorized by the ASHRAE Publications Committee but **only to be made available if enough pre-publication orders are received to justify the project.**

Please indicate below if you are interested in this Bulletin at the prices indicated; which vary only to reflect the total quantities that may be printed.

NAME .....

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I am interested in this proposed Bulletin and would accept a charge of $1.50 or $3.00.

SIGNATURE .....

dustry and to introduce profitable new products. Box 107, ASHRAE JOURNAL.

AVAILABLE

ENGINEER—Design, Manufacturing, Application, Sales available. Member ASHRAE, age 34, married. 6 yr excellent background in design, testing and manufacturing heating and ventilating equipment. Desires responsible position. Will relocate. Resume on request. Box 102, ASHRAE JOURNAL.

AIR CONDITIONING, HEATING & REFRIGERATION ENGINEER—P.E. with degree in Electrical BSEE and Mechanical MSME desires employment as an Application or Product design engineer with manufacturer of Refrigeration and Air Conditioning equipment. 7 yr experience in design and application of different types of heating, refrigeration, and air conditioning systems. Will relocate. Resume on request. Box 105, ASHRAE JOURNAL.

JR. ENGINEER—Affiliate ASHRAE, Engineer-in-training (Ohio exam). 3 yr M.E. (nights), 4 yr experience in heating, refrigeration and air conditioning. Desire challenging position with progressive Chicago area firm. Box 106, ASHRAE JOURNAL.

HVAC DESIGNER—Assoc. member ASHRAE, 3 yr college. 10 yr experience in small Consulting Engineer office, last 4 yr as chief designer. All types of systems in institutional and commercial buildings. Present duties include design, in charge of draftsmen, spec writing, shop drawings, and job inspections. Resume on request. Box 109, ASHRAE JOURNAL.

MANAGING ENGINEER—Managed mechanical contracting business since 1946. Experience in contract closure, estimating, designing, purchasing, supervising installations of domestic and commercial plumbing, heating, refrigeration, and air conditioning jobs. Age 40, health good. Desire challenging position. Box 110, ASHRAE JOURNAL.

MECHANICAL ENGINEER—BME, MS. 8 yr diversified experience in design and development of air conditioning equipment. Experience includes commercial and military applications. Interested in position with sound future. Willing to relocate preferably to West Coast. Box 112, ASHRAE JOURNAL.

EXECUTIVE—available. Extensive experience in all phases of heating, air conditioning and refrigeration: sales, contracting, purchasing, manufacturing, development. Consultant 26 yr. Experience abroad in Iran and Israel. Personable, well educated, enthusiastic. Willing to travel abroad or relocate. Full member ASHRAE. Resume, references, photo on request. Box 113, ASHRAE JOURNAL.

SALES ENGINEER—Leading refrigeration and air conditioning equipment manufacturer's sales engineer available. Entering independent manufacturer's representative field in New England. 20 yr experience with architects, engineers and users in this territory. Desire quality lines for aggressive promotion. Registered professional engineer. Box 114, ASHRAE JOURNAL.

AIR CONDITIONING and HEAT PUMP ENGINEER—25 yr experience, 3 yr college. Strong and broad background with major manufacturers. Qualified in sales, application and service engineering, technical writing and training programs, architect, engineer and distributor contacting. Mechanical contracting experience. Desires position where mature age and background can be utilized to mutual advantage. Resume on request. Box 979, ASHRAE JOURNAL.

McDonnell Flow Switches—Points out the almost endless uses of flow switches for safety control and automatic control. Covers details of construction, service ranges, applications.

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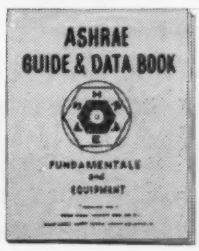

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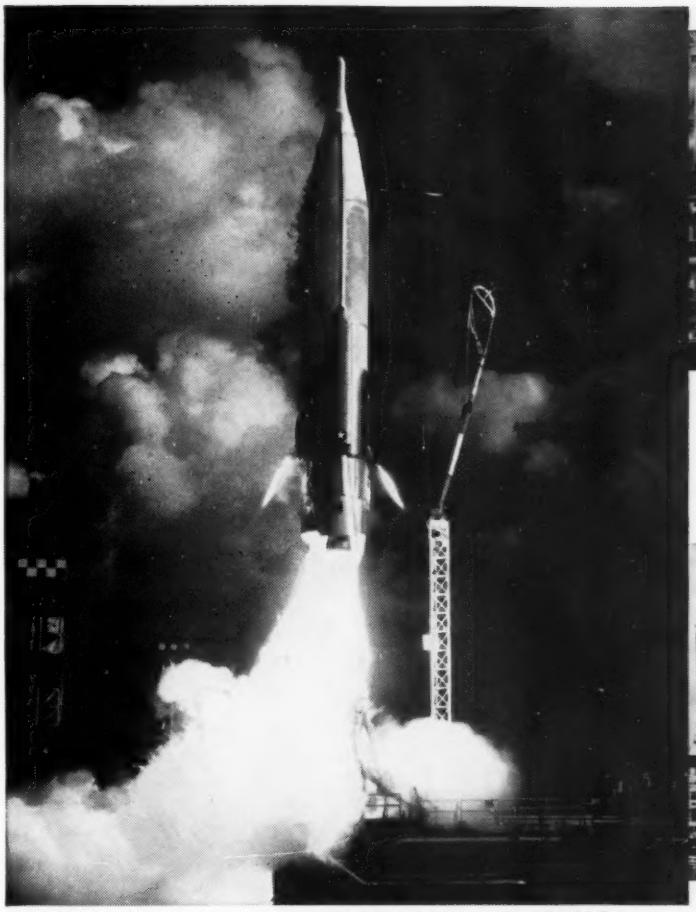
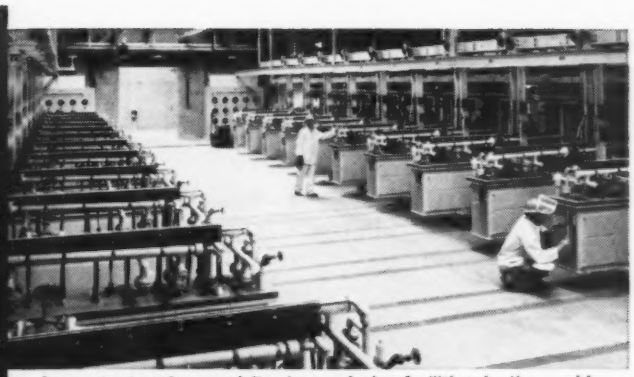
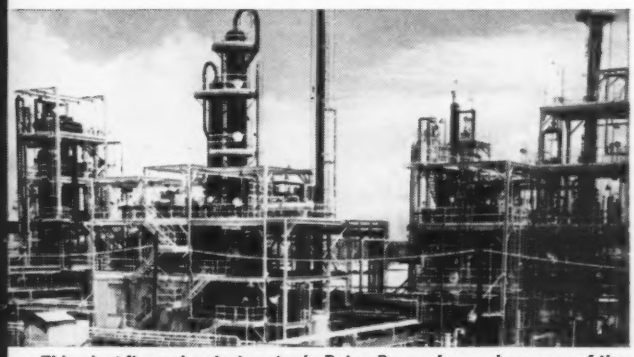


Providing tremendous thrust, new rocket fuel oxidizers such as liquid fluorine, chlorine trifluoride and other halogen fluorides may help us conquer space. Like "Genetron" fluorinated hydrocarbon refrigerants, they are important developments of General's long research in fluorine chemistry.



Largest privately-owned fluorine producing facilities in the world are located at General Chemical's Metropolis, Ill., Works. In these cells elemental fluorine is produced for use as a high-energy oxidizer of rocket fuels and for production of uranium hexafluoride for the Atomic Energy Commission. Allied Chemical's leadership in fluorine chemistry is applied to continuing improvement of "Genetron" refrigerants.



This giant fluorochemical center in Baton Rouge, La., makes many of the fluorine-based compounds required by industry and is a major production center for "Genetron" refrigerants. "Genetron" refrigerants are also manufactured in Danville, Illinois. Soon a new plant in Elizabeth, N. J., will provide a large new source for "Genetron" refrigerants.

What do rockets have to do with genetron® super-dry refrigerants?

Just this. Part of the "big push" into outer space may come from fluorine-based propellants now being supplied by General Chemical to the nation's rocket and missile research centers. The same know-how that makes General Chemical the leader in fluorine chemistry applies equally in other areas—especially in the development and production of "Genetron" fluorinated hydrocarbon refrigerants.

Behind "Genetron" Super-Dry Refrigerants is a research organization which is internationally recognized for its work in fluorine chemistry. Even more important to every user of "Genetron" refrigerants are the Company's advanced manufacturing facilities, which have helped bring quality standards for fluorinated hydrocarbon refrigerants to new highs of purity and dryness—a major contribution in itself.

"Genetron" Refrigerants are approved, accepted, *preferred* because they are *performance-proved.* Refrigeration engineers, contractors and servicemen endorse them. Wholesalers recommend them.

It makes sense to rely on the leader in fluorine chemistry for fluorinated hydrocarbon refrigerants. Next time you order, insist on "Genetron" and be sure of the best! Available from wholesalers everywhere.

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"Before we switched to Arkla-Servel gas cooling, we were plagued by failures in another type of air conditioning system. In less than two years we had to pull it out. But now, after more than six years of service, our 25-ton Arkla-Servel gas absorption chiller hasn't failed us once. It serves 52 units, each with individual control. And it costs us much less to operate."

That's the word from William H. Phillips, who keeps his guests cool and costs down with Arkla-Servel gas cooling. One central system, powered by steam from a gas-fired boiler, cools in summer, heats in winter. And thrifty gas keeps fuel costs low.

Enjoy trouble-free year 'round air conditioning with Arkla-Servel Gas cooling. For details on Arkla-Servel units, call your local Gas Company. Or write Arkla Air Conditioning Corporation, General Sales Office, 812 Main Street, Little Rock, Arkansas.

American Gas Association.

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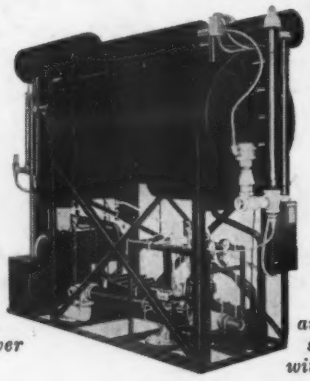

Arkla-Servel 25-ton gas absorption units use low pressure steam from a gas-fired boiler to power the chillers. They are compact, easy to install. They adjust automatically to heat loads, since their capacity increases with rising temperatures.

NEW PRODUCTS

(*Continued from page* 100)

tivity down to zero to ten micron full scale (0.00039 in.). In every range, internal calibration is available, permitting calibration of meter and transducer to a high degree of precision. A special terminal for connecting output of the meter into an oscilloscope or high speed recorder is provided for making permanent records.
Korfund Company, Inc., Cantiague Rd., Westbury, N. Y.

BASEBOARD HEATERS

Installed ankle-high at room perimeters to offset heat loss and maintain temperatures, these new forced hot water baseboard heating units have no grilles. Air enters a continuous opening at the floor line, passes over the heating element and flows out through a continuous opening at the top. All elements are completely enclosed.

Additionally, air warms the metal face of the baseboard itself, forming a continuous radiant panel. By natural convection, the heated air blankets exposed walls and window area and direct radiant heat from the unit adds warmth to floor and lower portions of the room. Two standard sizes are available, 9½ in. high by 2⅞ in. deep and 11¾ in. high by 3-3/16 in. deep.
Modine Manufacturing Company, 1500 DeKoven Ave., Racine, Wisc.

CANDIDATES FOR MEMBERSHIP

(*Continued from page* 88)

ZASLER, M. S., Design Engr., Victor Gruen, Beverly Hills.

Oregon

HABEL, H. B., Sales Engr., Arrow-Hart & Hegeman Elec., Portland.

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ASHRAE 1960 TRANSACTIONS

Following precedent volumes and 6 x 9 in., cloth bound, ASHRAE TRANSACTIONS covering 1960 will go to press shortly.

Included will be the full record of Society events, the Semiannual Meeting in Dallas, the Annual Meeting in Vancouver (including technical papers presented at both National Meetings and discussions upon them), listings of national officers and committees, records of Chapter personnel and other established features.

As directed by the ASHRAE Executive Committee, the 1960 TRANSACTIONS will be issued in but a limited quantity and will be priced at $3.00. Previously, this book was distributed to Society members, upon specific request, without charge. Thus, those wishing to obtain a copy of the 1960 TRANSACTIONS are requested to return the form shown below.

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I wish to have a copy of the ASHRAE 1960 TRANSACTIONS. You may bill me $3.00.

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Applications

CREATIVE ARTS BUILDING GETS CONTROLLED CLIMATE

Located in the warm climate of the San Francisco Bay area, the new Creative Arts Building of Pittsburg, Calif., High School required incorporation of year-round air conditioning into the building design. Zone control was necessitated by varying temperature conditions in the building's auditorium and by diversity of building usage. Selected for the system were a hermetically sealed centrifugal water chiller and cast iron hot water boilers.

To generate chilled water through a central air conditioning plant and remote equipment rooms for cooling and dehumidification, as required, a 125-hp Trane Hermatic CenTraVac was installed. For winter heating and reheat as required during the cooling season, a large cast iron boiler approved for 80 psi working pressure will generate hot water. Installed in the central mechanical equipment room, a graphic supervisory data center indicates dry bulb temperatures throughout the various zones and certain critical points in the system. This center automatically programs the chilled and hot water plants as dictated by zone thermostats and humidistats throughout the building.

Chilled water is circulated in a closed loop in the chiller room by a central pump. For each conditioning unit, an individual circulating pump draws water as required from this loop and delivers chilled water blended with by-pass water to its zone cooling coil. Water from the coils is either returned to the CenTraVac for recooling or bypassed through a three-way blending valve. Reheat is provided by a hot water coil downstream from the cooling coil. Winter heating is provided in a similar manner to cooling—constant water volume through the heating coil, using a separate circulator for each zone.

HANGAR DOOR HEATER FACILITATES WINTER FLIGHTS

To prevent frozen hangar doors, a completely packaged electric heating unit was installed on the hangar used by American Can Company at Westchester County Airport. Manufactured by Hynes Electric Heating Company, the heater is a 48-kw, 160,000-Btu/hr fluid heat transfer unit connecting with pipelines embedded in concrete just under hangar door rails. Four lines of 1½-in. Schedule 40 steel pipe beneath the rails form a pipe coil through which oil at 85 F is circulated.

An electric heating unit was chosen in preference to oil-fired equipment because of compactness, safety and ease of installation. Heater is used only when icing conditions are prevalent or expected, and is started manually several hours in advance of the expected arrival of bad weather.

TWO-PART SYSTEM TO CONDITION SYRACUSE APARTMENT BUILDING

To prevent seepage of air from living spaces along corridors, a two-part system will be installed in Imperial Gardens, a fully air conditioned apartment building under construction in Syracuse, N. Y. One half of the system will supply conditioned outside air to apartments and hallways from central apparatus in the basement. Air sent into the apartments will equal that removed through fan-driven exhausts located in kitchens and lavatories. In the other half of the system, 375 Carrier fan-coil units located under windows will maintain comfortable temperature and humidity levels in the 115 apartments. Each unit can be controlled individually by the tenant. Two hot water boilers and a Carrier water chilling machine with cooling capacity of 250 ton will be in the basement.

CHAPTERS REGIONAL COMMITTEE

MEETINGS AHEAD

REGION I, Boston Chapter (Boston), Oct. 10-11
REGION III, Richmond Chapter (Williamsburg), Oct. 19-20
REGION IV, Atlanta Chapter (Atlanta), Oct. 19-20
REGION V, Central Indiana Chapter (Indianapolis), Oct. 24
REGION VI, Iowa Chapter (Des Moines), Nov. 2
REGION VII, Kansas City Chapter (Kansas City), Nov. 3

BULLETINS

(*Continued from page* 110)

from units discharging air directly into a 7 x 11-ft test room with no ductwork or outlets to provide additional attenuation.
Bucnsod-Stacey, Inc., 45 W. 18th St., New York 11, N. Y.

Steam Traps. Diagrammatic drawings show operational characteristics, design, materials used and construction of four styles of thermostatic radiator traps: corner, straightway, vertical and angle; and eight models of float and thermostatic traps, including Model 69B which, because it has two inlets and two outlets, can be installed in any one of four operating positions. Roughing in dimensions and capacity tables for all models are shown. Incorporated in this four-page bulletin are two others: No. 102, Thermostatic Radiator Traps, and No. 202, Float and Thermostatic Traps.
Sterling, Inc., 5200 W. Clinton Ave., Milwaukee 23, Wisc.

Pump Catalog. Covered in 32-page Catalog 460 are rotary positive, four-wing type double and single – cylinder, two-wing type, high vacuum, automatically controlled, rotary oil-less, integral air and vacuum and motor-driven pumps; air motors; gas boosters, oiling systems; filters; and separators. Specifications, dimensions and diagrammatic illustrations are included, as well as a separate section on engineering data.
Leiman Bros., Inc., P. O. Box 1339, Newark 1, N. J.

Air Handling Units. Available at ratings from 400 to 30,000 cfm for cooling, heating, ventilating, humidifying, dehumidifying, filtering and air conditioning, Centralaire air handling units are the subject of 16-page Bulletin 404. Extensive specifications and engineering information are included.
Airtherm Manufacturing Company, Heating & Air Conditioning Div, P. O. Box 7039, St. Louis 77, Mo.

Water Conditioning Manual. How to secure clear, non-corrosive, non-clogging, non-precipitating water for commercial, industrial and home use is described in 24-page Bulletin MA-DP-10M-7-60, "Water Conditioning with Karlsonite for Preventive Maintenance." Use of chemicals as water conditioners for cooling towers, evaporative condensers, water-cooled equipment and other applications is covered in detail. Water testing instructions, installation procedures and water data and conversion tables are also included.
Stiles-Karlsonite Corporation, 1550 Grand Ave., Waukegan, Ill.

Heaters. Plant heating problems in the metalworking industry and solutions offered by overhead recirculating, fresh air supply and door heaters are discussed in four-page Bulletin MI-60. Covered are problems of proper warm air distribution in areas full of machinery or stocks of raw materials, replacement of air exhausted by fume removal systems and tempering of cold air inrush through shipping doors. Diagrams and photographs illustrate applications.
L. J. Wing Manufacturing Company Div, Aero Supply Manufacturing Company, Inc., 140 Vreeland Mills Rd., Linden, N. J.

Nylon Hose Fittings and Assemblies. Four-page Bulletin BR-3HF on Nylaflow nylon pressure hose contains a hose selector and data on an extensive range of re-usable fittings. Instructions for applying fittings and information on ordering assemblies are included. Hose is available in burst pressure ratings of 5000 and 8000 psi with inside diam from ⅛ to ½ in.
Polymer Corporation of Pennsylvania, 2140 Fairmont Ave., Reading, Pa.

Cooling Controls. Bulletin 1487-AN, on mechanical cooling and air conditioning controls, includes a line of coded control centers for air conditioning and several new items listed for the first time. Fan centers, cooling centers and system centers are catalogued and all-range water valves, Series 246, are shown from ⅜ through 1½-in. sizes.
Penn Controls, Inc., Goshen, Ind.

Steam Converter Catalog. Descriptive of a new line of steam converters for heating radiation water with steam, 22-page Catalog 1460 indicates advantages of these units in such applications as large installations when zoning is desirable and steam as the source of heat may simplify piping design and reduce design work required for exclusive use of water. Included in the catalog are specifications, operation data, leaving water tables from 170 through 230 F, piping installation diagram and water side pressure drop curves.
Dunham-Bush, Inc., 179 South St., West Hartford 10, Conn.

Registers, Grilles, Diffusers. 72-page Catalog 60-AC utilizes a color-coding arrangement so that data on any individual product in the air control line can be obtained easily. Pertinent information, including unit illustrations, specifications, capacities, selection charts, dimensions, installation diagrams and instructions, is offered for an extensive line of registers, grilles, diffusers and self-drilling and sheet metal (tapping) screws.
Air Control Products, Inc., Coopersville, Mich.

Valves and Accessories. Descriptive of more than 100 different types of shut-off, pressure relief and flow check valves, driers, filter-driers, strainers, liquid gauges, flanged unions, liquid indicators and moisture-liquid indicators, 20-page Catalog No. 104 contains extensive engineering information. Several pages of the booklet discuss filter-driers which feature a combination of granular desiccant and molded core to provide two-stage drying and acid removal with progressive filtration.
Henry Valve Company, 3215 North Ave., Melrose Park, Ill.

Ice Flake Machine. Two models available, a ¼-hp hermetic condensing unit with a capacity of 250 lb of ice flakes in 24 hr and a 1/3-hp unit with a capacity of 300 lb, are discussed in a four-page bulletin. Featured on both models is an ice auger, set in an evaporator of wrapped-coil construction designed to obtain max freezing. The entire auger assembly may be lifted out of the machine in seconds and completely disassembled, for ease of cleaning and servicing.
Freez King Corporation, 2518 W. Montrose Ave., Chicago 18, Ill.

Duct Furnaces. Installation of duct furnaces downstream of cooling surface in air conditioning systems is cited as being practical with this new line of furnaces, when equipped with optional stainless steel drain pan. Built-in by-pass offered as standard equipment eliminates need for addition of a separate by-pass duct to handle the greater cfm required by systems which provide cooling. Offered in six sizes ranging from 75,000 to 300,000 Btu/hr input, all models are AGA approved for use on natural mixed or LP gases. Controls are designed for 24-volt service and can be converted to 115 and 230-volt operation by means of a transformer. Six-page Bulletin 659-B describes and illustrates the new line, giving extensive specification and performance data.
Modine Manufacturing Company, 1500 DeKoven Ave., Racine, Wisc.